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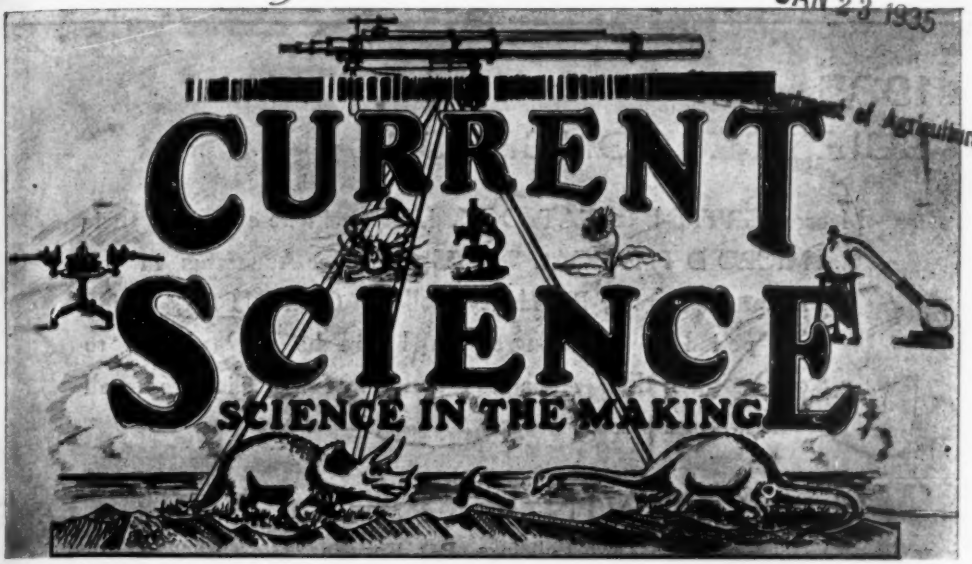

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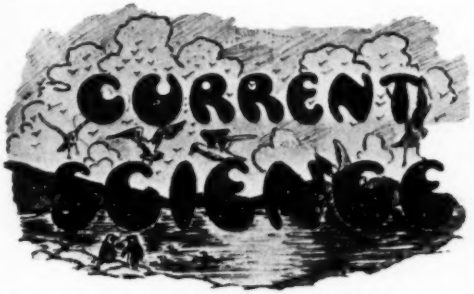

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CONTENTS.

Inland Fisheries in India.

THE *Statesman* of Calcutta recently published a series of short articles on "Fisheries of the Punjab" contributed by a correspondent. These articles disclose an inside knowledge of the working of the Department of Fisheries in the Punjab, and raise certain problems of such fundamental importance in regard to its administration and scientific aspects, that we think it necessary in the interests of the fishing industry to invite public attention to them.

Some twenty years ago when the Punjab Government organised the Fisheries Department, Mr. G. C. L. Howell, I.C.S., was placed in charge of its destinies. This appointment was in general conformity with the doctrine which all the governments used fondly to entertain (on the basis of the principles of facultative psychology), that a member of Civil Service is good enough for every conceivable branch of administration. The reason why a civilian is not appointed as head of the Cavendish Laboratory may, however, be found in the fact that it is not an earning department and its output is not immediately taxable. But in all industrial concerns where a deep scientific knowledge and technical training are indispensable for efficient and successful management of their affairs, Government assumes that the administrative experience of its officers is more than their equivalent. It is true that the general administrative officers possess alertness of mind, a comprehensive vision, tact, ability and application, but neither any one of these qualities nor all of them together will avail in the management of departments in which an intensive scientific training, technical experience, acquaintance with the methods of research and ability to initiate original investigations are required for making the concern a remunerative one; knowledge of revenue collection and of the penal code must, at all times, be a poor substitute for these qualities. The administrative duties in the fishery and agricultural departments are considerable and responsible, and it seems to us that the head of such departments must also be a research worker himself so as to be able to guide the laboratory work of his assistants, to assess their results and suggest problems for fresh investigations. Moreover, the administrative functions of

scientific departments are not identical with those of the general branches of government, and a blank mind, which is not often the supreme qualification of even a judicial officer, can never be an equipment for scientific posts. The prevailing practice of appointing civil officers as heads of technical and scientific departments is due to the fact that Government, which expends money on their organisation, desires to control their output, and no one is more competent to advise Government on the subject of prices and taxation than its civil servants. An industry, whose scientific problems are subjected to considerations of prices and taxation, must ultimately become as inefficient as an industry that has no scientific problems. An industry without a civilian head to control its affairs is as blessed as a country which has no history.

The correspondent of the *Statesman* suggests in the concluding portion of his contribution that the research work on Fisheries in the Punjab should be closed down "until such time as adequate funds are available to place it on a proper footing, with a pisciculturist from Europe or America at its head". This is just the kind of advice that a civilian administrator of scientific departments would, in a spirit of despair, tender to the government when its financial resources might temporarily be dislocated; but the viewpoint of a scientist would precisely be the opposite. A time of economic depression is manifestly the psychological moment for the display of financial courage and technical skill, for if the lines of scientific investigation in the government industrial departments have been carefully planned with reference to the experimental and other environmental conditions, then it would be realised that the only protection against depression is more research. If the major industries such as agriculture,—and under their category we would also include pisciculture,—are ultimately to be depended upon for the restoration of financial stability, then the suggestion for the curtailment of research, even as a provisional measure, would appear to be fatal to the best interests of government. We have had occasion (*Curr. Sci.*, Oct. 1933) to comment on the subject of research on Fishery work while reviewing Mr. Sorley's report on the Marine Fisheries of the Bombay Presidency, and we would repeat once more that if research work is entrusted to competent persons, then government will find it profitable to invest more funds in its promotion. The prosperity of any industrial organisation must depend upon continuous and anticipatory scientific research, and industrial prosperity implies the financial stability of government. In the existing scheme of competitive internationalism, the advocacy of the policy of closing down research departments of government industries, such as is advocated by the correspondent of the *Statesman* and Mr. Sorley, can only be accepted on the responsibility of placing the country in a state of perpetual dependence on foreign products.

The second proposal made by the correspondent, *viz.*, that a European or an American pisciculturist ought to be appointed as head of the fisheries department in the Punjab betrays his ignorance on the subject of fisheries research in India. An American or European pisciculturist may be a very eminent scientist in his own country, but in the widely different conditions prevailing in the tropics, he will generally find that he has to unlearn a great part of his training and experience before he can understand the complicated situation arising from the vagaries of the dry Indian climate, the rainfalls which obey no known law, the little understood habits of fishes which still have to be studied more intimately, the diverse customs and practices of the country, the nature of the rivers and tanks and the uses made of their waters for irrigational purposes. In the case of all appointments of foreign scientists, a more or less prolonged period of self-education in the complicated and unfamiliar local conditions must necessarily precede the acquisition of anything like a clear grasp of the situation and the nature of Indian problems. If these scientists are really capable men, they may begin to gather experience of fishery work in the tropics during the probationary period and start on some useful lines of scientific investigation, otherwise they drift into the administrative branches of their department. In fact, it has been a singular misfortune of the Fishery Researches in India that, after Francis Day, persons, without competent knowledge and experience of the peculiar local conditions, have been appointed in most of the provinces, with the result that their efforts have been always unsatisfactory. So far in the Punjab there have been two directors of the department, but neither

of them could claim to possess any scientific training or previous experience of fishery work, and accordingly they attended only to the administrative aspect of their work to the detriment of the more important side of scientific enquiries. The department needs the scientific atmosphere and inspiration for the junior workers, and they can be provided only by the unbounded zeal of the head of the department who must be an intrepid research worker himself.

The Department of Fisheries in the Punjab at the time it was established set out to achieve a three-fold object, *viz.*, to conserve all the species of fish then held by the rivers and tanks through regulation of the methods of fishing and the abolition of uneconomic and wasteful devices adopted by the fishermen; to discover the habits and life-histories of the more important forms with a view to breeding them in captivity; and to attend to the interests of the fishermen castes and to bring back many to the trades of their forefathers. These are simple propositions and of these the second only is scientific, capable of being accomplished by a steady pursuit of the subject. According to the correspondent of the *Statesman* when a research officer was appointed in 1920, "it was confidently hoped that this branch would develop, but fourteen years have elapsed and except that he has been accommodated where he has access to a fine laboratory, research as such is no further advanced." The research officer alluded to is a young inexperienced graduate of the Punjab University, and he was expected to work miracles, without special training and necessary guidance by the head of the department. If the Fisheries Department of the Punjab was unable to discover the general habits and life-history of the carp (*Labeo rohita*) in order to stock the rivers of the province, the blame attaches to the defective planning of the department. We have no hesitation in maintaining that the official head of the department must be a scientist, possessing competent knowledge and training and capable of conducting original investigations himself and directing those of his subordinates. The post ought not to be offered to civilians whose interest in the development of the scientific sections cannot be expected to be more than academic; and it is uncharitable to require them to guide researches for which they possess neither adequate knowledge nor previous training.

According to the testimony of the writer in the *Statesman* the Fisheries Department has achieved a certain measure of success in reclaiming those fishermen whom the system of *begar* (labour for government servants without remuneration) had driven to basket-making. This is certainly a great departmental achievement. But it must be remembered that the system of *begar*, in any event, is bound to become obsolete on account of the spread of education and the growth of political consciousness. Will the suppression of unremunerated labour by official authority and police vigilance keep the fishermen to the profession of their forefathers? The reports of the Bombay and Madras Fisheries departments deplore the increasing tendency of fishermen to take to more lucrative professions in considerable numbers, and this is only part of the universal phenomenon of the defection of industrial communities from their traditional occupations. This is due to two causes. In the first place the doctrine of proportional representation in government appointments and local bodies and legislative chambers has stimulated the competitive ambitions of every section of population to acquire and exercise political and administrative authority. Perhaps, the second cause must be the discovery, that the education that is imparted to the children of the industrial people, has no relation to their occupational activities, but tends only to produce a decided aversion for them. More than all these, the rapid industrialisation of the urban areas must, by the offer of higher wages, deplete the villages, whose population once drawn into the welter of distractions of the cities is permanently lost to rural occupations. Fishermen are not saints. To enable them to pursue their traditional profession in happiness, peace and contentment, to make them realise that an intensive and scientific cultivation of their industry will bring them increasing prosperity and political power, and to induce them to take a legitimate pride in their descent from Peter and John, are problems of such magnitude and importance that, in the successful solution of at least some of them, the head of the Punjab Fisheries Department might reasonably take pride, but assuredly not in the suppression of the *begar* system.

Regarding the scientific work of the

Fisheries Department we read in the *Statesman* that "efforts to breed the indigenous fish of the country ended in a failure" and the next paragraph opens with the sentence "the only direction in which the department could point to with some pride was the introduction of the trout". If the cultivation of this foreign species is thriving in the streams of the Punjab Hills, the department is, however, unable to account for its success. Besides, an act of this nature, manifestly undertaken in a playful mood to gratify a whimsical curiosity, but not based on scientific prescience, is fraught with intricate and numerous biological consequences. In Madras the experiment of trout breeding is proceeding, and the effects of successful cultivation of foreign species on the population of indigenous forms must be carefully watched. In our existing incomplete knowledge of the feeding and breeding habits of many of the local forms of fish, the introduction of foreign fish into their midst might possibly disturb the balance of life, and lead to the rapid diminution and ultimate extinction of the former. Any interference with the delicate adjustment of life in restricted areas by clumsy experiments, which are usually attended by disastrous results, is an act which few trained and experienced scientists would lightly undertake, and palpably it must be in the nature of a speculative adventure.

The suggestions made by the correspondent in regard to the establishment of sanctuaries for the propagation of indigenous fish deserve immediate public attention and comments were made on this subject in *Current Science* (*vide* issue for July 1933). In the Punjab with its network of rivers and canals, facilities for the creation of a number of sanctuaries exist, and the delay in the formulation of a scientific scheme for conservation and propagation of fish is unaccountable. The utilisation of river and tank waters largely for irrigation purposes must unfortunately have an adverse effect on the general habits of fishes, and in all irrigation projects, due attention should be paid to the needs of the fishery of the country. Dr. Francis Day has made valuable suggestions on this subject in his Reports on Fish and Fisheries of India, which are available to the heads of the Fisheries Department for consultation, and we have no doubt that many of them can, with a slight improvement, be adopted to suit the particular circumstances of the provinces.

In his last note, the correspondent deplores the fact that "on the retirement of the late Warden the post was abolished and Fisheries Department was placed directly under the Director of Agriculture as a separate entity." It is to be remembered that in every civilised country, a combined Ministry of Agriculture and Fishery has been found to be a great advantage both as a measure of securing economy and unitary administrative control over the two industries, whose problems cross one another in several ways. In India the political divisions, especially in the older Presidencies like Bombay and Madras, are far too extensive and varied in geographical features, to be brought under a unitary scientific or administrative control. In Madras where a few years ago, higher education used to be directed by a single University, it is now under the management of five or six universities, and we think that it would be advantageous to split each of the larger presidencies into at least two divisions for the purposes of developing the Agricultural and Fishery Departments. The first step in this much-needed decentralisation is to separate Marine Fisheries from Inland Fisheries. The latter is to be divided into two departments in conformity with a similar bifurcation of the Agricultural Department. They should then be put in administrative charge of one Director for each of the divisions, and the two departments should be provided with a separate well-equipped laboratory under competent scientific staff. For the purpose of coordinating the results and the initiation of new problems in pisciculture, the creation of a new Central Bureau of Fishery Research under the control of the Member of the Department of Education, Land and Public Health, becomes a matter of imperative necessity. Our considered opinion is that the establishment of this central scientific organisation is overdue. Early in September, the Advisory Board of the Imperial Council of Agricultural Research held a prolonged discussion on the conditions of the Fisheries industry and the possibility of its development. It was generally agreed that there was great need for the appointment of an expert committee to investigate the question in all its aspects, and it was announced in the papers that the Fisheries Committee would soon be instituted. It is

hoped that the terms of reference to the Committee, when established, will be sufficiently wide and elastic, so as to permit an exhaustive enquiry being undertaken. Those who have actually done research on fish and fisheries in India are few, and we have no doubt that the wealth of knowledge and experience accumulated by individual scientists will be found invaluable in conducting the enquiry by the Committee. We confidently hope that sufficient room will be found for experts on this proposed Committee whose proceedings will be followed with earnestness by the public, whose interest in the development of the food resources of the country is manifestly increasing.

Some Recent Advances in Indian Geology.*

By W. D. West,
Geological Survey of India.

3. The Geology of the Himalaya.

DURING the past ten years or so considerable progress has been made in our knowledge of the geology of the Himalaya, which has only served to show how complicated is the geology of this great range and how great is our ignorance of its real structure. During this period work by the Geological Survey of India has mainly been concentrated in two areas, the North-West Himalaya in Hazara and Kashmir, and the Simla hills around Simla and Chakrata; while in addition there have been several foreign expeditions to the Karakoram and neighbouring tracts beyond the Himalaya which have added something to our knowledge of the geology of those parts. Thus in spite of large blanks still existing on the geological map of the Himalaya, largely accounted for by the inaccessibility of Nepal, the accumulating results of steady mapping are gradually providing a sure foundation on which may ultimately be built a complete synthesis of Himalayan geology. Theories of mountain structure based on our present incomplete knowledge of even one section of the Himalaya must necessarily be largely speculative. They arrive almost by every mail, and are frequently advanced by those whose acquaintance with Himalayan geology is by no means extensive. Perhaps of no part of Indian geology can one more truly say that the more one knows of it the more one realises how little one knows. The present policy of the Geological Survey is to concentrate its small available resources on two sections of the Himalaya, as stated above, in the belief that a sustained attack on these two selected areas will yield more valuable knowledge of the geological structure of the Himalaya as a whole than a larger number of smaller investigations spread over a wider area. The summary that follows, therefore, deals mostly with these two areas. In compiling it the writer is indebted to his colleague Mr. J. B. Auden for many fruitful discussions on the problems raised therein.

THE NORTH-WEST HIMALAYA.

The most striking feature in the orogeny of the North-West Himalaya is the way the strike of the mountains, after following an arcuate S.E.—N.W. direction for over 1,200 miles from Assam to Kashmir, makes a great bend in Hazara, rapidly curving round through an E.—W. to a N.—S. direction, and producing thereby a great re-entrant angle in the alignment of the mountains between Abbottabad on the South-West and the Kashmir valley on the North-East. This bend is seen not only in the frontal ranges bordering the Indo-Gangetic alluvium, but is repeated in each successive range northwards, culminating in the Pamir massif. Even this great mass shows the same trend lines, which are south-west on the west, equatorial through the Pamirs, and south-east on the east side, as first determined by D. L. Ivanow and subsequently confirmed by Sir Henry Hayden.[1] As regards the origin of this feature, it had previously been supposed by E. Suess in his great work 'Das Antlitz der Erde' that the rapid change in the strike of the mountains was due to the meeting at an oblique angle of two mountain systems, the Himalaya and the Hindu Kush.[2] For this line of meeting

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[1] *Rec. Geol. Surv. Ind.*, 1916, **45**, 271.
[2] *The Face of the Earth*, 1904, **1**, 422.

Suess used the term 'schaarung', which was translated by Sollas as 'syntaxis'. The following quotation from the English edition gives his conclusions:

"Like two shallow streams of lava, or two flows of slag running side by side, the waves of which as they cool come into syntaxis against a long line, now fusing completely together, now encroaching on one another, so the chains of the Himalaya meet those of the Hindu Kush."

He especially emphasised, however, the essential unity of the movements, and the unity of structure of the whole. Quite recently D. N. Wadia's work in the more southern portion of this syntaxial area has shown that both from a structural as well as from a stratigraphical point of view there is a complete continuity of Himalayan geology around this re-entrant, at any rate on its southern border, the structure and stratigraphy on the Hazara side of the syntaxis being the mirror image of the structure and stratigraphy on the Kashmir side, as originally pointed out by Middlemiss.[3] Instead, therefore, of two directions of mountain movement having converged upon Hazara, the Hindu Kush from the north-west and the Himalaya from the north-east, as envisaged by Suess, Wadia concludes that there has been a single Himalayan movement from the north which has come up against some underground obstacle around which it has been forced to diverge. It is suggested by him that a tongue of the ancient and stable peninsular rocks extends upto the north-west beneath a covering of Kainozoic rocks, and that this has formed the obstacle to the folding movement coming from the north, so that the original north and south direction of movement has been resolved into a N.E.—S.W. direction in Kashmir, and a N.W.—S.E. direction in Hazara. There still, however, remains the difficulty of explaining how the W.S.W. to E.N.E. direction of overthrust which is found on the south-west side of the syntaxis, in the neighbourhood of Garhi Habibulla, can have originated in a movement coming from the north. This latter problem was discussed briefly by J. W. Gregory, who suggested that the older supposed 'Altaid' mass of the Safed Koh in the country west of Peshawar may have been responsible for this backward movement.[4] Recently D. Muschketoff has suggested that this 'Jhelum wedge', as he calls the underground obstacle, has been a tectonic feature of importance since Caledonian times, and has been responsible for a number of abnormalities such as the N.N.W.—S.S.E. direction of the Ferghana range, which although of Kainozoic age runs at right angles to the main Himalayan trend lines on either side.[5] A complete understanding of the origin of this great orogenic feature will probably have to await further information concerning the structure of the Hindu Kush, the Karakoram, the Pamirs, and the country north of the Pamirs.

In that part of the syntaxial area investigated by Wadia, three structural elements are defined: (1) a 'foreland' consisting of a great thickness of moderately folded Murree (Miocene) rocks, overlying the supposed tongue of Peninsular India; (2) a belt of autochthonous rocks thrust (the Murree thrust) against the foreland of Murrees, comprising rocks ranging in age from Carboniferous to Eocene, but consisting essentially of a recumbent fold of Eocene rocks, with a core of Panjal trap; and (3) a 'nappe' zone of central Himalayan rocks, which has travelled far along a nearly horizontal thrust plane (the Panjal thrust), so as to lie with marked discordance sometimes upon the rocks of the autochthonous zone and sometimes directly on the rocks of the foreland. This Kashmir 'nappe', as Wadia calls it, is composed, in the syntaxial area, mostly of Dogra (=Attock) slates and the Salkhala series (=Jutogh series of the Simla hills). The former are thought to be lowest Cambrian or older, and the latter Archæan (see table below), the whole 'nappe' being the oldest part of the Himalayan geosyncline which has been overfolded and travelled along a thrust plane many miles from its original place of deposition. To the east of the syntaxial area, and lying upon the top of the 'nappe' in the form of a synclinal basin, and forming the Shamsh Abari mountains, there occurs a thick sequence of Palæozoic rocks, including Lower Palæozoic, Devonian (Muth quartzite), Panjal volcanic rocks and Trias. The well-known Kashmir basin of sedimentary rocks occupies a very similar position further east. In his most recent paper Wadia has described the sequence in this north-west part of Kashmir

[3] *Rec. Geol. Surv. Ind.*, 1931, **65**, 189 and *op. cit.*, 1911, **41**, 136-7.

[4] *The Structure of Asia*, 1929, 12.

[5] *Sixteenth Internat. Geol. Congr. Wash.*, Abstract of Papers, 1933.

State.[6] It differs from the sequence worked out by Middlemiss in south-east Kashmir in two ways: (1) it shows a full development of the Cambrian with a good trilobite fauna; (2) it includes an extensive mid-Palæozoic unconformity, there being a gap between the top of the Silurian and the middle of the Carboniferous, which is not found in the rest of Kashmir or in Spiti. This new work is also of interest in showing a passage from the unfossiliferous slate series up into beds bearing annelids and other organic remains, and of these up into beds containing trilobites and brachiopods of Middle Cambrian affinities. According to F. R. C. Reed, "nearly all the species are new, while there is little resemblance to the faunas of corresponding age in the Central Himalaya or northern China. . . . The Cambrian of the Salt range has quite a different assemblage of fossils." It seems likely, therefore, that the Dogra Slates, which underlie these beds, are lower Cambrian or Purana in age. But until fossils have been found in actual Attock, Dogra, or Simla Slates, the age of these rocks must remain in doubt.

Before leaving this area mention must be made of the finding by Wadia of scratched boulders in the Tanakki conglomerate near Abbottabad, where it underlies the Infra-Trias limestone.[7] This find, together with his further observation that the Infra-Trias limestone is interbedded with the Agglomeratic Slate in North Hazara, adds further strength to the contention, first made by R. D. Oldham, that this conglomerate or boulder bed is homotaxial with the Talchir glacial boulder bed, and therefore Upper Carboniferous in age.[8]

An important paper recently published on the geology of Kashmir deals with the researches of C. S. Middlemiss and H. S. Bion on the Agglomeratic Slate series and the Panjal Trap, work that was in progress at the time of the outbreak of the Great War.[9] The Agglomeratic Slate series occurs lying immediately below the great series of bedded basic lavas known as the Panjal Trap, up into which it appears to pass by interbedding. These two series, over most of the area, keep to an horizon between the Middle Carboniferous and the Permian, that is to say at the junction of the Dravidian and Aryan groups, a datum line of great importance in Indian geology, though these limits do not hold good everywhere. Previously found to be destitute of organic remains, the Agglomeratic Slate has been found by these two investigators to be fossiliferous in a few places. To quote from their memoir:

> "This temporarily overlooked fauna is of much intrinsic interest, some of it being new to Himalayan geology and helping to bridge the gap between the middle part of the Carboniferous (as represented by the Fenestella shales) and the Permian which immediately overlies the Panjal volcanics at most points—a gap that had been assumed previously to have been wholly given over to vulcanicity in this region."

As regards the mode of origin of this series, Middlemiss suggested that either it was the product of explosive volcanic action, preparatory to the outpouring of the Panjal Traps, or it was due to ice action, the beds thus being homotaxial with the Talchir beds of peninsular India. He was inclined to favour the first hypothesis. Another peculiar point which puzzled Middlemiss and Bion is clearly brought out by them in this paper, namely, that the Agglomeratic Slate and the Panjal Trap together exhibit in certain areas a very inconstant horizon. Thus the lowest horizon at which the Agglomeratic Slate appears in different sections is very variable, ranging from Middle Carboniferous (Moscovian) to the top of the Uralian. The top of the Panjal Trap shows an even greater variability, ranging from just below the Gangomopteris beds up to the base of the Upper Trias. Thus the total length of time during which vulcanicity occurred in one place or another was from the Middle Carboniferous to the close of the Middle Trias, an immense period of time, queerly contrasted with certain areas where it was restricted to the limits of the Permian only. Further peculiarities noted by these workers included two thick lenticular bands of Triassic limestone interbedded with the Panjal Trap, one of which was surrounded on all sides by trap. The total of these observations led Middlemiss to consider whether the Panjal Traps were not lava flows but intrusive sills, and therefore later in age than the base of the Upper Trias. He even suggests the possibility of their being contemporaneous with the great outpouring of similar basic lavas in peninsular India known as the Deccan Trap, which commenced at the close of the Mesozoic. More recent work by D. N. Wadia on the Pir Panjal range, which borders Kashmir on the

[6] *Rec. Geol. Surv. Ind.*, 1929, **68**, 121.
[7] *Op. cit.*, 1929, **62**, 153.
[8] *Op. cit.*, 1930, **63**, 130.
[9] *Pal. Ind.*, N. S., 1928, **12**.

south, has shown that the Agglomeratic Slate series is undeniably volcanic in origin, as is clear from the presence of unaltered as well as devitrified glass in one or two specimens, in which are embedded phenocrysts of orthoclase, plagioclase and quartz.[10] That the greater part of the Panjal Trap consists of sub-ærial lava flows is also concluded by Wadia; and the problems indicated by Middlemiss and Bion, referred to above, do not appear to affect the main conclusions, and may be of only local significance, though they still require solution. As regards its composition, the Panjal Trap is shown by Wadia to consist of abundant flows of basalt, which are generally epidotised to give the familiar bright green colour of these rocks. In places their total thickness is over 5,000 feet. Recently it has been pointed out by K. K. Mathur and S. N. Wakhaloo that volcanic rocks of a more acid type, approaching to rhyolites, are also to be found in this series, being abundant in the vicinity of Srinagar.[11]

While referring to this part of the Himalaya it is convenient to record here that Lydekker's view that the axis of the Pir Panjal is composed of granite has been shown by Middlemiss and Wadia to be incorrect.[12] The greater part of the summit zone is composed either of Panjal Trap or the Agglomeratic Slate series, with small outcrops of Gondwanas.

The Great Himalaya range is generally regarded by geographers, and rightly so, as ending at the Indus, where the great mass of Nanga Parbat dominates everything. Further north-west, beyond the Indus, there are no great heights to suggest its continuation in that direction. Geologically speaking, however, it is continued round the hairpin bend of the Punjab re-entrant into North-East Hazara, as shown by Wadia, and it is probably correct to regard it as terminating, in a geological sense, near Garhi Habibulla, north-east of Abbottabad, where the last of the Salkhala series, belonging to the Central Himalayan zone, are seen. The geology of Nanga Parbat and the adjoining country has recently been described by D. N. Wadia, who shows it to consist of four main elements.[13] These are: (1) para-gneisses, greatly intruded by gneissose granite ('central gneiss' type); (2) the Pre-Cambrian Salkhala series; (3) a mixed zone situated between (1) and (2), consisting of Salkhala series penetrated by gneiss; and (4) great masses of intrusive dolerite and epidiorite. Nanga Parbat itself consists of (1). Wadia was naturally unable to examine the rocks of the main peak itself. But from the evidence of boulders in moraines he thought it was probably composed of gneissose granite. But Dr. P. Misch, who accompanied this year's expedition to Nanga Parbat, states that the mountain is composed entirely of group (1) as given above. The dolerites and epidiorites are regarded by Wadia as genetically connected with the Panjal Trap lava flows, of which they are the hypabyssal phase. In addition to the gneissose granite or 'central gneiss' of Stoliczka, there is a younger hornblende-granite which is post-Panjal Trap in age.

ASSOCIATED RANGES TO THE NORTH.

Coming now to that region of the Himalaya and beyond which has of late been investigated by a number of foreign expeditions, the facts at our disposal are very much fewer, and it is difficult to be certain of the age and mutual relations of some of these ranges. This, added to the fact that geographers and geologists seem to take a different view of what is meant by a range, makes the correct interpretation of a number of isolated observations a matter of some difficulty. Moreover, the country covered by these expeditions does not strictly come within the Himalayan area. Certain points, however, may be referred to, which are of interest to the student of the Himalaya. As has already been pointed out, the Pamirs are to be regarded as the culmination northwards of the great Punjab re-entrant. And since both it and the associated ranges on either side, and the Hindu Kush and the Karakoram further south, conform to the trend lines of this re-entrant, it is natural to expect these mountain ranges to be of Himalayan origin, at least in part. North of the Pamirs the same trend lines are no longer evident. But until a great deal more is known of these mountains, and any older structures which they may show differentiated from their later Himalayan

[10] *Mem. Geol. Surv. Ind.*, 1928, **51**, 238–242.

[11] *Curr. Sci.*, 1933, **2**, 126. Since writing the above Mr. Wadia has informed me that in his opinion these rocks are in the main ordinary Panjal Trap which has been silicified, and not true acid volcanic rocks.

[12] *Rec. Geol. Surv. Ind.*, 1911, **41**, 134; and *Mem. Geol. Surv. Ind.*, 1928, **51**, 223.

[13] *Rec. Geol. Surv. Ind.*, 1932, **66**, 212.

structure, it is best not to be too dogmatic. As regards the relations between the Himalaya and its associated ranges up to the Karakoram on the one hand, and the Kun Lun, the Tian Shan and other ranges to the north on the other hand, it has generally been accepted by geologists, following Suess, that the former group are Kainozoic in age, belonging to Suess's 'Alpides', and the latter of Hercynian age, belonging to his 'Altaids'. E. Argand, however, in his attempted synthesis of Asiatic tectonics, regards the whole as essentially Alpine, any pre-existing 'Altaid' structures having in his view been destroyed in the great Alpine paroxysm.[14] Argand, however, has been proved to be wrong in so many of his conclusions, as for example in Persia, that we may well hesitate before accepting his ideas. According to the more recent field work of E. Trinkler and H. de Terra in the Karakoram and the West Kun Lun, the Karakoram ranges are regarded as Hercynian in age, while their present Himalayan features are attributed to later epeirogenic movements accompanied by extensive faulting.[15] They would therefore group the Karakoram with the Kun Lun in being structurally Palæozoic mountains. In writing of the granite core of the Karakoram, de Terra remarks on the fact that it is underlain everywhere by crystalline rocks, and suggests that the granite has been thrust by mountain making processes over different formations. In this it closely resembles the behaviour of much of the central Himalayan gneissose-granite and its associated crystalline rocks, which appear in so many places to be thrust over the underlying rocks, a problem which is referred to again below. The old controversy as to the course of the Karakoram east of longitude 78° seems to be settling itself as our knowledge of the geography and geology of these areas progresses, and there can now be little doubt that the Karakoram extend E.S.E. and E. right on into the Tibetan plateau.

THE HIMALAYAN ARC.

In all these discussions it is generally assumed that Gondwanaland played a passive rôle, and that it was the southward move of the rest of Asia against Gondwanaland which buckled up the soft marine deposits of the Tethys, and caused them to be thrust over the edge of Gondwanaland, which to some extent broke along its northern border. But it is of course equally conceivable that it was Gondwanaland which moved against Asia, crumpling up the rocks of the Tethys, and underthrusting itself beneath them. The writer has always failed to understand how one can expect to decide whether Asia moved south and over Gondwanaland, or whether Gondwanaland moved north and under Asia, by observing the structure of the country along the line of thrusting, though others appear to think it possible.[16] There is, however, one line of reasoning which seems to throw light on this problem, and that involves a consideration of the position of Asia with respect to the rest of the world before and after the movement. This point of view has been developed by P. Lake, who, in a paper on island arcs and mountain building, has drawn attention to the fact that the well-known arcs off the Pacific coast of Asia, the East Indian arc through Sumatra and Java, the Himalayan arc, and the Iranian arc of Persia, which are all of Kainozoic age, all have their convex side facing away from Asia, the Pacific arcs facing east, and the others facing south or south-west.[17] We are thus required to explain how a single Asiatic mass can have moved along its eastern border towards the Pacific and at the same time along its southern border towards the Indian Ocean. As Lake points out, a movement of the mass as a whole in both directions does not seem possible, but underthrusting of the ocean-floor from both sides is conceivable, and is, in fact, a necessary consequence of the contraction theory or of Joly's theory. This view receives additional support from a consideration of the central Asian mass itself. Had the earth's crust spread outwards radially from central Asia, we should expect to find a deficiency of matter at the centre of the continent, as Burrard has pointed out.[18] But in fact the reverse is the case, and there is an excess of mass protruding above the spheroidal surface which has nothing to equal it elsewhere on the globe. Consequently the alternative hypothesis, that there has been a general pressure acting

[14] *La Tectonique de L'Asie*, 1924.

[15] *Geologische Forschungen im Westlichen Kun Lun und Karakoram-Himalaya*, 1932.

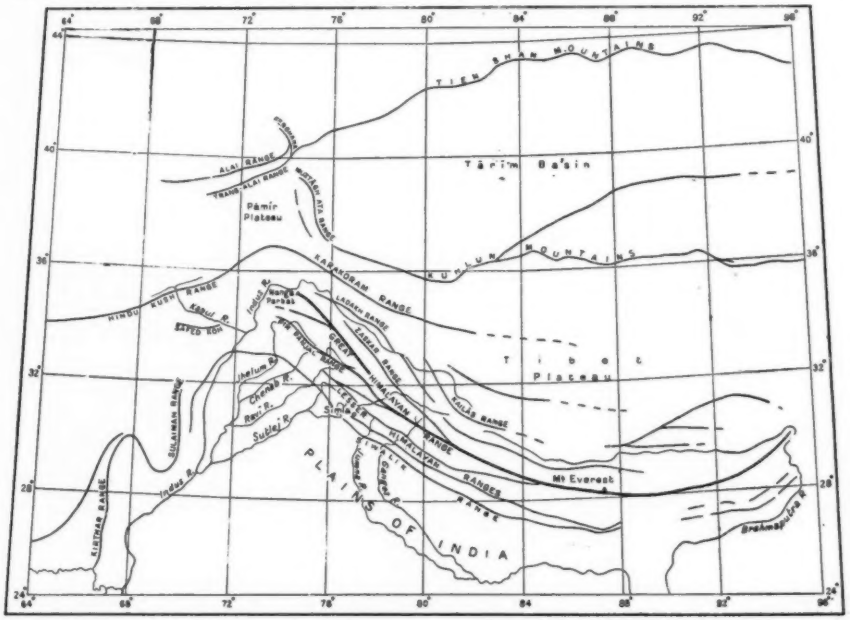
[16] N. E. Odell, *Geogr. Journ.*, 1931, **78**, 159.

[17] *Loc. cit.*, 149.

[18] *A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet*, 2nd Edn., 1934, 77.

towards central Asia, seems to be the more acceptable.

The further suggestion developed by Lake in this same paper, that all mountain arcs which have the shape of an arc of a circle, have been formed by movement of a slice of the earth's crust along a single basal thrust plane, and in particular its application to the Himalaya, is one which, in spite of (or because of) its simplicity, is not in accord with the observed facts. Although the Himalayan arc can be shown to be part of a circle, with its pole in Central Asia, it must be remembered that, geologically considered, the Himalaya are but a part of a much more extensive mountain system, which continues to the south-west through Baluchistan and Persia, and to the south-east through Burma. And since they have been formed on the site of a long geosyncline by the crushing of its deposits through the movement of Eurasia and Gondwanaland towards one another, the shape of the mountain system so produced must be determined partly by the original disposition of the geosyncline, and partly by the shape of the two impinging masses. Further, as shown by Wadia in the Punjab re-entrant, there is a continuity of geological structure around this feature which forbids one to bring the Himalaya (geologically considered) to an end at Nanga Parbat, the point at which Lake has to end his Himalayan arc. Moreover, as recently pointed out by Auden, our increasing knowledge of the structure of the Himalaya shows that not only are there a number of thrust planes of paramount importance within the Himalaya, but also that the angle of these thrusts is extremely variable and does not conform to the low angle required by Lake's hypothesis. As he says, it would appear impossible to regard any single dislocation or nappe as having borne the whole burden of the advance upon the foreland.[19]



Trend Lines of the Mountain Ranges of the Himalaya and Tibet.
(Mainly after Burrard).

Fig. 1.

On the other hand, Burrard, as a geographer, considers that there is no Himalayan arc at all; for in his opinion the Himalaya cannot be considered independently of the mountains further north, including the Kun Lun, the Tien Shan, the Karakoram and the Hindu Kush, ranges

[19] *Rec. Geol. Surv. Ind.*, 1934, **67**, 448.

which either show no curvature at all, or curve northwards.[20] But this view ignores the important geological fact that while the Himalaya and its immediately associated mountain ranges are, at any rate mainly, of Kainozoic age, the Kun Lun, the Tien Shan, and possibly the others also, are much older having been formed most probably at the end of the Palæozoic (Hercynian). It does, however, contain a germ of truth. It is a well-established principle that older structures frequently play an important part in influencing the formation of later structures. And although the great Himalayan arc is no doubt to be regarded as essentially Kainozoic in origin, it is yet a moot point as to the extent to which an older 'grain' may still be preserved within the main Kainozoic superstructure. The point is referred to again below.

To make clear the foregoing remarks, the main trend lines are shown in Fig. 1, which is mainly copied from the frontispiece of Burrard and Heron's *A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet*, with certain additions and simplification.

(To be continued.)

[20] Reference 18, p. 75.

Progress of Algological Studies in India.

By K. Biswas, M.A.,

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THE study of Botany dates as far back as somewhere 2,500 years ago. But apart from its mainly applied side not much attempt was made to investigate the Indian plants from purely scientific aspect. The first impetus to the systematic study of Indian Botany was given by the Governor of Malabar by the publication of the memorable volume entitled *Hortus Malabaricus* during the last decade of the 17th century. But the critical study of Indian plants along the modern lines was systematically taken up by Dr. William Roxburgh, 'the father of Indian Botany', since his appointment as the first Superintendent of the Royal Botanic Garden, Calcutta, the then East India Company's garden, in 1793, although Dr. Roxburgh for many years prior to his transfer to the Royal Botanic Garden had been engaged in studying the then little known flora of the Northern Circars in the Madras Presidency.

Very little attempt was, however, made to investigate the lower plants of this vast country. Bryophyta and algæ were left untouched till very late years, although study of these branches of Botany was started in Europe earlier than 1753—from the time of Linnaeus onwards.

Dr. Alexander Braun and Dr. W. H. Hervey mentioned about Belanger's and Wight's collection of Chara and seaweeds as early as 1826-28. Collection and study of algæ can thus be traced from the period of 1798 onward, when var. *Ceylonica* of *Chara polyphylla* A. Braun, was first detected in Ceylon by Lebeck in 1798 (according to Klein in *Herb. Willd*), and afterwards collected near Tranqueber. Robert Wight, M.D., F.R.S., the distinguished Indian Botanist, and a member of the Honorable Company's Madras establishment, published the Icones Plantarum Indiæ Orientalis. He issued, in collaboration with Dr. Walker Arnott, the first volume of Prodromus Floræ Orientalis, an admirable work which unfortunately was never completed. Iyengar's[*] reference to Wight's algal work in this volume cannot be traced. As far as could be found from the literature available at my disposal Belanger was the first to admire the treasures of the Indian Sea. In 1836, as Director of the Botanic Gardens in Pondicherry, he collected seaweeds along the coasts of Cape Comorin and its neighbourhood in South India. Jaimes Forbes Royle, Late of the medical staff of the Bengal Army, added a short note on Algæ in his monumental work on the "Illustrations of the Botany and other branches of the Natural History of the Himalayan Mountains and of the Flora of Cashmere," 1839, Vol. I, pp. 441-442. In this note Royle suggests that "the Dictyoteæ

[*] Iyengar, M. O. P., Presidential Address (Section of Botany), Fifteenth Indian Science Congress, 1929.

increase in numbers as we approach the equator; and *Hypnea, Cystoseria, Sargassum, Zonaria, Spharococcus, Thamneria, Acanthophora, Tamnophora, Amansia, Caulerpa*, and *Gelidium*, of which swallows build the so much prized 'edible bird's nests' abound in tropical seas. Few have been described from the Indian Ocean, but several are contained in Dr. Rottler's Herbarium." He also mentioned that "A few species of Confervas" are found in Dr. Rottler's Herbarium from the neighbourhood of Tranqueber. I do not find mention of "snow algæ in the Himalayas and some Lemaneaceæ in the cold mountain torrents" as stated by Prof. M. O. P. Iyengar. Royle simply makes a general remark about "Red snow which may be found in the Himalayas together with some freshwater Confervæ", while of the true Fuci, the Lemanias are only found in the freshwater of mountain torrents. Royle's note on the economic uses of the algæ is also very suggestive.

William Griffith, a Surgeon in the Honourable Company's Madras establishment, was one of the most brilliant of the Indian Botanists, who had had a varied interest and extensive knowledge in different branches of Botany. Huge accumulations of his gatherings from different parts of the Indian Empire and Malay Peninsula and his vast accumulations of notes and manuscripts were posthumously published in nine volumes under the editorship of Dr. McClelland at the expense of the Honourable Company during the middle of the 19th century. Among his papers of 1849, on Cryptogams are published with illustrations seven members of the family of Characeæ, a highly specialised group of algæ. Of these *Chara involucrata, C. erythrogyna, Chara* sp. and *C. furcata* were collected from Serampore, Bengal; *C. soluta* from Hardwar, U.P., and *C. spagnoides* from "cabul". His new species named after Voigt—*Lysimoscepas voigtii*, as Griffith's figures show is a *Chara* sp. Prof. Iyengar's remark that "Griffith has described and has figured six Characeæ from upper India and Kabul", mentioned in his presidential address, is thus modified more accurately here. There is hardly any mention of algæ in Griffith's work "on Cryptogamic plants of Dr. Roxburgh in Flora Indica of Roxburgh" as referred to by Iyengar, in Vol. IV, *Cal. Jour. Nat. Hist.*, 1844, noted in the list of literature appended to Iyengar's presidential address. In 1849 Dr. Alexander Braun made a contribution entitled "Characeæ Indiæ Orientalis et insularum maris pacifici"—published in Hooker's *Journal of Botany*, Vol. I, pp. 292-301. In this paper Braun has described four species of *Nitella* and eight species of *Chara*, most of which were collected by Belanger during 1826-28 on the coast of Coromandel and by Dr. Wight. The collections were preserved in Hooker's Herbarium. Dr. W. H. Hervey described in 1854 three charming sea-plants from the south coast of Ceylon under three genera, of which the genus *Vanvoorstia* named after the reputed naturalist John Van Voorst, author of the *Natural History of Great Britain*, was established for the first time by him. The three species mentioned are *Vanvoorstia spectabilis, Claudea multifida* and *Martensia spectabilis*. In 1858 H. J. Carter paid attention, for the first time, to the fertilisation of *Eudorina elegans* collected from some puddles in Bombay, and also reported occurrence of a few other members of Volvocaceæ and Flagelatta from the same locality including a new species of *Ceratium* from Lake Nynee (Nainital), Kumaon. This was published in the *Ann. and Mag. of Nat. Hist.*, 1871, whereas his former paper on "Ficundation in *Eudorina elegans* and *Cryptoglena*" and "on the Ficundation of two volvoces and their specific differences" were published in the *Ann. and Mag. of Nat. Hist.*, 1858 and 1859. Dr. G. C. Wallich in the *Ann. and Mag. of Nat. Hist.*, 1860, **5**, 3rd Series, No. 27, pp. 184-197, wrote on the "Descriptions of Desmidiaceæ from Lower Bengal". He mentions seven genera and eight species of filamentous Desmidiaceæ, namely, *Hyalotheca, Desmidium, Ap'ogonium, Sphærozosma, Leusonema, Onychonema* and *Streptonema*, together with his observations on the periodicity of these algæ which were obtained from the neighbourhood of Raneegunge during the latter months of 1855. The same author, Surgeon Wallich of the Indian Army, read an interesting paper on the "Siliceous organisms found in the digestive cavities of the Salpæ and their relation to the Flint nodules of the Chalk formation," before the Transactions of the Microscopical Society, London, on December 14th, 1859. This noteworthy publication "intended to embrace under this head the whole of the molluscoid tribes that frequent the open sea in shoals and live upon the microscopic organisms it contains," is published in the *Trans. of the Micro. Soc. Lond.*, New Series, 1860, **8**,

36-55. A. Grunow wrote an account on the Freshwater Diatoms and Desmids of the Banka Island near Singapore in his paper entitled "Süsswasser—Diatomaceen und Dismidiaceen von der Insel Banka" in *Rab. Beitr. Zur. Ken. U. Verb. Algen, Leipzig*, 1865. Hobson in the *Quarterly Journal of the Micro. Science*, wrote: "Notes on Indian Desmidiaceæ" in 1863, and described two new species *Docidium Pistidæ* Hobs., *Micrasterias Mahabuleshwarensis* Hobs., collected from Mahabuleshwar, Bombay Presidency. Dr. G. V. Martens, High Councillor of Finance in Stuttgard, during 1871-73 published in the *Proc. of the Asiatic Society of Bengal* the result of his work on "Some Bengal and Burmese algæ collected by S. Kurz". In the *Journal of the Asiatic Society of Bengal*, 1873, **42**, G. Zellar recorded 155 species of algæ collected by S. Kurz from Arracan and British Burma. In 1879 Leuduger-Fortmorel drew up a "Catalogue des Diatomees de L'ile de Ceylon". A few interesting algæ collected from the Himalayas were examined by Dr. G. Dickie, F.R.S., and his "Notes on algæ from the Himalayas" was published in the *Journal of Linn. Soc. Bot.*, 1882, **19**. His note is supplemented by Grunow's report. W. Theobald added "A List of Burmese Desmids" in *Burma : Its People and Productions*, **2**, 16-30, 1883. W. Joshua recorded "Two Desmids from Rangoon" in *Jour. of Botany*, 1885. Next year the same author added a valuable contribution on "Burmese Desmidiaceæ" together with coloured illustrations in the *Jour. of the Linn. Soc. Bot.*, 1886, **21**, enumerating 186 species and varieties. J. Schaarschmidt in his "Notes on Afghanistan Algæ," published in the *Jour. of the Linn. Soc. Bot.*, 1886, **21**, described 60 species of algæ which were all carefully separated and examined from dried materials adhering to phanerogamic specimens chiefly to *Ammania pentandra*. These phanerogams were collected by Dr. J. E. C. Aitchinson, Surgeon-Major to H. M. Bengal Army in the Afghanistan expedition of 1880. G. Murray is the author of "Catalogue of Ceylon algæ in the Herbarium of British Museum", which was published in the *Ann. and Mag. of Nat. Hist. Lond.*, 1887. G. Lagerheim contributed towards our knowledge of Bengal Desmids in his paper entitled "Über Desmidiaceen Aus Bengalen" in *Akad. Handl.*, 1888, **13**, Afd. iii, No. 9, where he refers to 52 species and varieties. Then follows the valuable memoir of Prof. W. B. Turner under the title of "Algæ aqua dulcis Indiæ orientalis," "Freshwater algæ of East India" in *Kong. Sv. Vet. Ak. Handl.* (1892), 1893, **25**, Part I, pp. 1–186, accompanied by 23 plates. The manuscript of this paper was compiled in 1885–86 but was published in 1892. The materials of this valuable contribution to Indian Algæ consist of residue of Dr. Wallich's collection of 1855 which was subsequently supplemented by that of Dr. G. Von Lagerheim, who sent to Prof. Turner some specimens of Indian Utricularias—from the Riks Museum in 1889. Turner in his work mentions 22 species of Myxophyceæ, 542 species of Desmids and 60 species of Chlorophyceæ exclusive of Desmids. It appears that some of the species demand reduction in their specific rank and alteration in their specific names in the light of the modern rules of nomenclature. But this point in no way lessens the great importance of the paper. His remarks on the periodicity of the algæ in relation to their habitat is worth consulting. W. West and G. S. West described in their paper on "Desmids from Singapore", 45 species from Singapore, Burma, which were collected by then by Mr. H. N. Ridley, and published in the *Jour. of the Linn. Soc.*, 1897, **33**. O. Borge's paper on "Über tropische und subtropische süsswasser—Chlorophyceen" in *Bih. Till. K. Sv. Vet. Akad. Handl.*, 1899, **24**, Afd. IV, No. 12, marks the closing of the study of Indian Algæ up to the year 1900. During the first decade of the 20th century literature on Indian Algæ was considerably enriched by the noteworthy publications of the well-known algologists—Profs. W. West and G. S West, Dr. Nils Svedelius and Prof. F. E. Fritsch. In the *Transactions of the Linn. Soc. Bot.*, Series 2, 1902, **6**, we find W. West's and G. S. West's article on "Freshwater Algæ from Ceylon". This valuable contribution on Freeman's collection of 7 species of Rhodophyceæ, 49 species of Diatoms, 33 species of Myxophyceæ, 246 species of Desmids and 81 species of other Chlorophyceæ appreciably advanced the progress of algological researches in India. Next year appeared the two important papers by Mrs. A. Gepp (Barton, E. S.). One of these is "List of Marine Algæ collected at the Maldive and Laccadive Islands by J. S. Gardiner" published in the *Jour. of Linn. Soc. Bot., London*, 1903, **35**, No. 247; and the other is "List of Marine Algæ with a note on the fructification of Halimeda" published in the

Report on the Pearl Oyster Fisheries of the Gulf of Mannar by W. A. Hardman in the *Jour. of the Royal Soc., London*, Pt. I, 1903. The valuable monograph on the "Report of the Marine Algæ of Ceylon, No. 1, Ecological and Systematic Studies of Ceylon species of Caulerpa," by N. Sreedelius was published in the "Biological Results of the Ceylon Pearl Fishery," No. 1, Art. 4, 1904. Sir David Prain in "The Vegetation of the Districts of Hughli, Howrah and 24 Pergunnahs" published in the *Rec. Bot. Surv. of India*, 1905, **3**, No. 2, reports 84 species of algæ from the three important districts of Bengal. W. West and G. S. West record 58 species of Diatoms, 148 species of Desmids and 53 species of other green algæ which were collected by Mr. I. H. Burkill chiefly from Burma. The result of their study is embodied in the *Annals of the Royal Botanic Garden*, Calcutta, 1907, **6**, Pt. 2, under the heading "Freshwater Algæ from Burma including a few from Bengal and Madras". F. E. Fritsch in his account on "A general consideration of the Sub-ærial and Freshwater Algal Flora of Ceylon", a contribution to the study of Tropical Algal Ecology, Pt. I, Subaerial Algæ and Algæ of the inland Freshwater published in the *Proceedings of the Royal Soc. of Lond.*, Series B, 1907, **79**, suggested extensive scope of studies on the ecology of algæ in India. The year 1911 concludes with W. West's short paper on "Descriptions of the new species of algæ associated with freshwater Polyzoa, with notes by Dr. N. Annandale" published in the *Jour. and Proc. of the Asiatic Soc. of Bengal* (New Series) **7**, No. 3. This marks the cessation of activities of the continental algologists working on Indian materials up to the year 1926 when Nellie Carter's "Freshwater Algæ from India" made further addition to the progress of Algological studies in India.

The period between 1911 and 1919 indicates a dormant stage in the history of Algological researches in India. In 1914 at the inaugural meeting of the Indian Science Congress at Nagpur, Dr. Paul Brühl while discussing the various avenues of researches on Indian Botany laid particular stress on the study of Algæ in India in consideration of the vast mines of Algal wealth of this country. He went even so far as to suggest the formation of an Algological Society in India which to the great enthusiasm and interest of Indian Botanists developed into the present Indian Botanical Society.

Then came the period of renaissance in the history of Algological researches in India. It is indeed a matter of glory and satisfaction that from 1920 up to the present, the contributors are nearly all Indians. The names of Dr. S. L. Ghose (Punjab), Prof. M. O. P. Iyengar (Madras), Dr. P. Brühl and K. Biswas (Bengal) may be mentioned as the pioneer workers in the study of Indian Algæ. Very lately Dr. Y. Bharadwaja is attempting to solve the mystery of the life history of several genera of blue-green algæ of the United Provinces. Prof. Dixit of Bombay Presidency has also, by his notes on algæ, evinced his interest in the study of this branch of Botany. Messrs. Handa and Paul have also by their publications advanced the progress of our knowledge of Burmese blue-green and green algæ and members of Characeæ. Our knowledge of Characeæ has considerably been advanced by the studies of J. Groves in his papers on "Charophyta from Ceylon" published in *Jour. Linn. Soc. Bot.*, 1922; and "Notes on Indian Charophyta," *Ibid.*, 1924, **46**. Paul's recent work on Characeæ was preceded by G. O. Allen's paper on "Notes on Charophyta from Gonda, U. P." published in *Jour. Bomb. Nat. Hist. Soc.*, 1925, and a few others. The papers of these Indian workers Ghose, Iyengar, Bharadwaj and the author of this article are too many to mention here. Ghose is chiefly interested in the blue-green algæ of the Punjab and about half a dozen of his important papers have already been absorbed in the literature on Indian Algæ. He is at present, in collaboration with his students, actively engaged in the study of algæ of the Punjab. Iyengar has mainly devoted his attention to the study of green algæ and out of his about a dozen important contributions to our knowledge of the Indian green algæ, his investigation on Echballocysts and Madras Volvocaceæ throws much light on many a doubtful problem in the life history of these algæ. The writer himself and in collaboration with Brühl added to the literature on Indian Algæ more than twenty papers including some of the memoirs containing descriptions of many new species and observations on the nature of the growth and distribution of the algæ recorded. Systematic morphology and ecology of blue-green and green algæ and also of Diatoms have at present been the favourite subjects for the study of the writer. Those who desire to have further information of the papers of the algologists mentioned above may correspond direct with them. Prof.

Borgesen who paid visits to the Bombay sea-coasts is at present engaged in the study of the marine species, and his recent publications are substantial additions to our knowledge of marine algæ of the Malabar coasts.

The progress of the study of Indian Algæ thus may be divided in three well-marked periods—first the early period: 1798-1860; secondly, the middle period: 1861-1900; thirdly, the recent period: 1901-1931. Regionally Bengal, Southern India and Burma including the Malaya Peninsula were the centres of activities from the early period up to the present time. Ghose and Bharadwaj are attempting to establish centres of algological studies in their own provinces too. It is hoped that in the near future batches of algologists in each of the provinces will be forthcoming to increase and further our knowledge of Indian Algæ.

The scope of Algological studies in India have already been discussed in the presidential addresses of Prof. M. O. P. Iyengar and Dr. S. L. Ghose as presidents of the Botany Section of the Indian Science Congress in 1929 and 1933; the author of this note in his contributions entitled "Census of the Indian Algæ—Scope of Algological Studies in India" Part I, published in *Revue Algologique*, 1932 Tom. **6**, Fasc. 2, and "Rôle of Aquatic Vegetation in the Biology of Indian Waters", published in Sir P. C. Ray's Memorial Volume, 1933, dealt upon the same subject. In consideration of the vast materials of Indian Algæ a school of Indian Algologists is necessary to work out materials of the unexplored areas. We have not yet been able to make a systematic survey and are still in the dark as to the number of species occurring in a locality and their distribution in different parts of the country. Very small percentage of the Indian species of Myxophyceæ, Chlorophyceæ and Diatoms are known to the world. The necessity of the investigation was also felt by the Government of India, as the following report of the thirty-sixth meeting of the Board of Scientific Advice to consider the proposal for reorganisation of the Botanical Survey of India indicates: "The appointment of a cryptogamic botanist to the Botanical Survey was urged by Sir D. Prain when Director of the Survey about 1900. It was strongly supported at home by Sir George King, the previous Director and by Thiselton Dyer, the head of Kew. The post was created in 1901, but was transferred to the Agricultural Department a year later and the incumbent instructed to specialise in the diseases of plants. Cryptogamic botany has not since formed any part of the activities of the Survey and the position still is that save as regards ferns no special attempt has ever been made by the Botanical Survey to prosecute the systematic study of the cryptogamic vegetation of the country, if we omit a few collections made during the last century." Sir David in a recent letter to the writer has again, even after so many years, emphasised the urgent need of algological investigation.

I can therefore safely assure a bright future for the enthusiasts in the study of Algology in India not only for the sake of study of this fascinating subject from the standpoint of pure scientific investigation, but also for the considerable importance of the practical utility of Algæ as food in pisciculture, antimalariological operation, filter-works, soil fertility and so on. Younger generation taking interest in this line can profitably undertake the study of Indian Algæ under the authorities and very well devote their life in advancing our knowledge of the vast unknown field of Algological investigation in India. Ghose and Iyengar, to my information, have already sufficient accumulated materials awaiting investigation of several workers. The writer also has in his possession precious collections of large amount of materials from the Late Dr. Dudgeon of Allahabad, the Late Rev. Dr. E. Blatter of Bombay and the Late Dr. S. K. Mukerjee of Lucknow—the three brilliant Indian Botanists, whose irreparable loss we all mourn to-day. The writer humbly hopes to dedicate the results of his works on these collections to each of these botanists and thereby commemorate their great interest in the progress of algological studies of our country, for which they spared no pains to gain these valuable materials properly preserved which is by no means an easy task.

On the Neural Gland, Nerve-Ganglion and Dorsal Tubercle of *Herdmania pallida* Lahille (the Typical Monascidian of the Indian Seas).

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THE monascidian *Herdmania pallida* Lahille[1] (*Rhabdocynthia pallida* Herdman) is dissected and studied as a type of the Tunicata in almost all the Universities of India, Burma and Ceylon. But no published account of its anatomy exists. Teachers and students usually seek help from accounts of *Ascidia*[2] and *Ciona*, the European monascidians, which are totally inadequate for a study of the Indian form *Herdmania*. The author has completely worked out the Anatomy, Histology, Bionomics and Distribution of this animal, a monograph on which will soon appear for use in the Indian Zoological Laboratories.

During the investigation a number of new and unexpected features have been found, but, in this article, the author confines himself to the structure, relationship and homology of the neural gland, nerve-ganglion and dorsal tubercle of *Herdmania pallida*. It may be mentioned here that, though a study of these three organs forms a very important part of the dissection of the ascidian in the graduate and post-graduate courses in Zoology, in India, their morphology has been wrongly interpreted for a decade or more since the substitution of ascidians from Tuticorin and Ennur for those formerly obtained from Naples and Plymouth.

The neural gland, nerve-ganglion and dorsal tubercle are all situated in the intersiphonal region of the animal, the former two lying imbedded in the mantle and the last projecting into the branchial cavity, in the prebranchial zone (Fig. 1). In the European forms *Ascidia* and *Ciona* the nerve-ganglion is situated dorsally to the neural gland (Fig. 2), but in *Herdmania* the nerve-ganglion always lies ventrally to the neural gland (Fig 1). This change in position is attended with an alteration not only in the general lay-out of the three organs but also in their size, form and structure.

The *neural gland*, lying just above the nerve-ganglion, is a light brown oval structure about 4 mms. long, 2 mms. wide and 1 mm. thick. The gland consists of a large number of branching tubules given out towards its periphery from a few central tubes which open into a long non-ciliated canal running along the whole length of the gland (Figs. 3 and 4). At its anterior end this canal leads into a duct that passes downwards, between the nerves given out from the ganglion, and opens into the antero-dorsal region of the branchial cavity by a wide

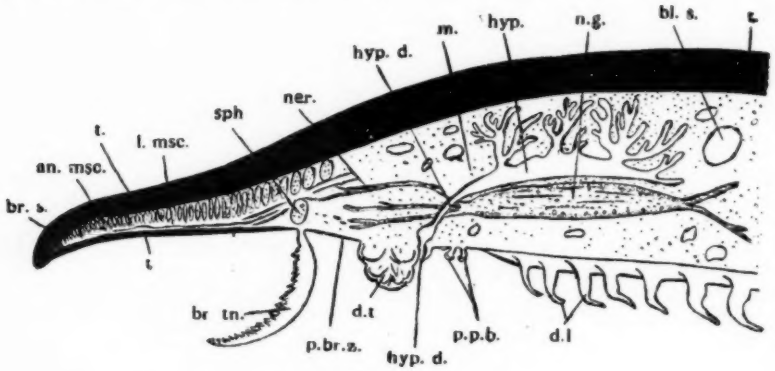

Fig. 1.

Longitudinal section of the neural gland, nerve-ganglion and dorsal tubercle of *Herdmania pallida*.

br. tn.—branchial tentacles; *d.l.*—dorsal lamina; *d.t.*—dorsal tubercle; *hyp.*—neural gland; *hyp.d.*—neural duct; *n.g.*—nerve-ganglion; *p.p.b.*—peri-pharyngeal bands.

[1] *C.R. Assoc., Franc. Sess.* 16, 1888, **2**, 677.

[2] *L.M B.C. Memoirs, Ascidia*, 1899.

ciliated funnel-shaped opening at the middle of the basal part of the dorsal tubercle. This wide funnel is absent in *Ascidia*. The lumen of the gland as well as its ducts are lined with a single layer of small non-ciliated rounded cells containing large nuclei. The rest of the gland consists of a large number of small dark granulated cells with large nuclei, some scattered blood-corpuscles and some blood-sinuses traversing the substance of the gland (Figs. 1, 3 and 4). A large

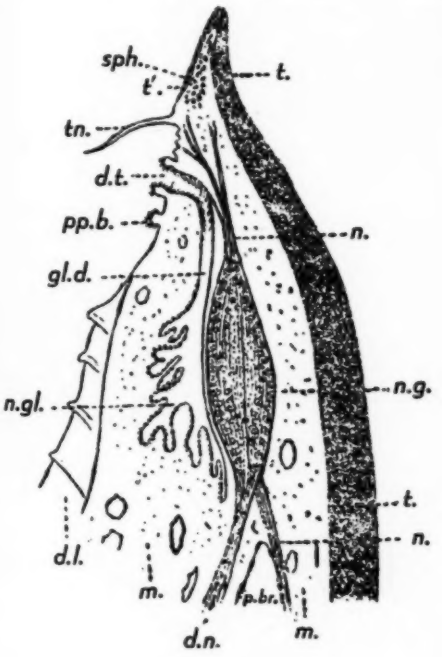

Fig. 2.

Longitudinal section of the nerve-ganglion, neural gland and dorsal tubercle of *Ascidia* (from Parker and Haswell).

n.g.—nerve-ganglion; *n.gl.*—neural gland; *d.t.*—dorsal tubercle.

number of cells filled with dark granules are discharged into the lumen of the gland, from where they pass out, through the main duct, into the branchial cavity. The dark granules are excretory products absorbed by the cells. The ciliated cells, lining the funnel-shaped opening, are of the same kind as those covering the dorsal tubercle, the cilia being about double the length of the cells themselves.

The *nerve-ganglion* forms an elongated, solid pinkish mass—about 4 mms. long and 1 mm. thick—lying ventrally to the neural gland. It gives off three nerves anteriorly (*i.e.*, towards the branchial siphon) and two posteriorly (*i.e.*, towards the atrial siphon) (Fig. 1). Of the three anterior nerves two are stouter than the third, and these, soon after their origin from the ganglion, diverge and run, one on each side of the posterior margin of the branchial siphon, along the base of the circle of tentacles. They thus approach each other on the ventral side of the branchial siphon and end in fibres that branch but do not anastamose. All along their length they send branches into the tentacles and to the muscles and inner epithelium of the siphons. The third nerve, which is finer than the other two, arises in between them and runs towards the branchial aperture, obliquely across the wall of the siphon, sending nerve-fibres to the muscles and the epithelium of the siphon. The two nerves arising from the posterior end of the ganglion diverge and encircle the base of the atrial siphon, sending branches to the muscles and the epithelium of the atrial siphon. The ganglion consists of an outer covering of very large cells with large nuclei and a main central zone of a loose fibrous matrix in which a large number of bi-polar and multi-polar nerve cells are imbedded. The large cells of the outermost layer—"the ganglion cells"—are oblong in outline and contain thickly granulated cytoplasm in which is imbedded a large nucleus. The central zone consists of a mass of inter-lacing nerve fibres in which a large number of nerve cells with two or more dendrites are scattered.

The *dorsal tubercle* is situated below the nerve-ganglion, in the pre-pharyngeal zone, near the junction of the peri-pharyngeal bands with the dorsal lamina. It consists of a broad base and two conical projections, each of which is formed of a spirally coiled lobe that tapers towards the summit of the tubercle (Fig. 1). In *Ascidia* and *Ciona* the tubercle is a simple horse-shoe-shaped structure, without the conical lobes, and is much smaller in size than in *Herdmania*. The basal part consists of a hemispherical concave lobe over which lies a convex dome-shaped lobe. In between the two spiral coils lie gaps or open channels which form a continuous open channel from the base of the tubercle to the tip of each cone (Fig. 3). The two channels of the two sides meet

under the dome-shaped hemispherical basal lobe, and form the concave base, in the centre of which the ciliated funnel opens. The general surface of the organ, except the bottom of the most proximal groove, is covered by a single layer of tall cylindrical

this organ, as Metcalf[3] and Hunter showed, points to a sensory function. The actual sensory function subserved may be gustatory or olfactory, or, as the author thinks, both—since both functions could be efficiently performed by a pre-pharyngeal sense-organ

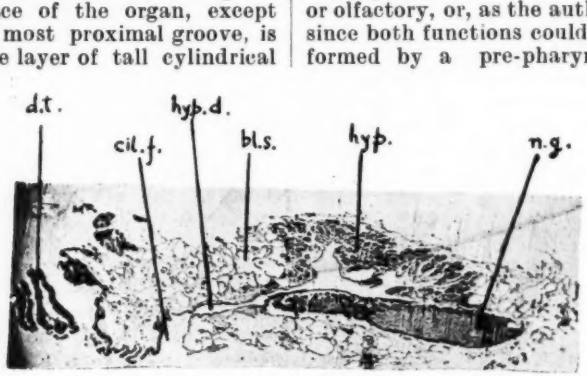

Fig. 3.

Photo-micrograph of a longitudinal section through the neural gland, nerve-ganglion and dorsal tubercle of *Herdmania pallida*.

bl.s.—blood-sinus; *cil f.*—ciliated funnel.

columnar epithelial cells copiously provided with very long cilia. The rest of the tubercle consists of loose connective tissue containing a large number of extensive blood-sinuses, connective tissue cells scattered throughout and a number of nerve-fibres

like the dorsal tubercle. Metcalf demonstrated that the opening of the neural gland into the pharynx is a modified neuro-pore and favoured the view put forward by Julin that the neural gland is the morphological equivalent of the hypophysis cerebri of

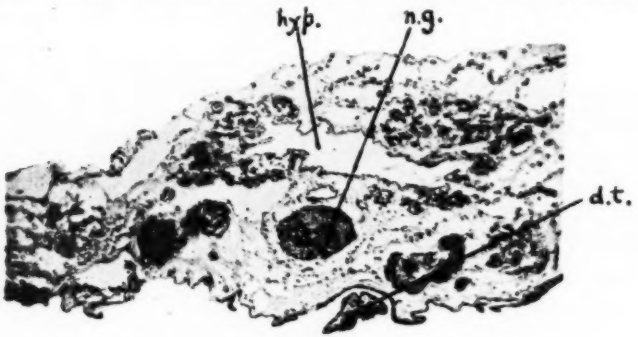

Fig. 4.

Transverse section through the neural gland, nerve-ganglion and dorsal tubercle of *Herdmania pallida* (Photo-micrograph).

that supply the covering epithelium of the organ.

The homology and function of the neural gland and the dorsal tubercle have been subjects of much dispute. Early investigators described the dorsal tubercle and the ciliated funnel as an olfactory organ. Julin considered it merely as the opening of the neural gland. But the rich innervation of

vertebrates. Julin also suggested that the gland subserves an excretory function. Lacaze-Duthiers[4] tried to establish the theory that the neural gland secretes mucus which is poured into the pre-pharyngeal zone of the gut and serves the purpose of

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[3] *J.R.M.S.*, 1901.

[4] *Mem. Acad. Sci. Inst. France*, T. 45, 1.

entangling microscopic food particles brought in with the water current. But this theory can in no way be correlated with the facts: (1) that the main work of food collection is done not in the pre-pharyngeal zone but in the pharynx itself, (2) that the endostyle is the main mucus secreting organ and supplies the peri-pharyngeal zone with the necessary mucus, and (3) that cells containing dark granules are secreted into the cavity of the neural gland and are discharged therefrom into the branchial cavity. The structure of the neural gland in *Herdmania*, the fact that the secretion of the gland originates by the disintegration of cells proliferated from the endothelium of its walls and the presence of dark granules in the excreted cells, strongly indicate that the gland subserves an excretory function. The opening of this gland at the base of the sensory dorsal tubercle is, however, a problematical association. But, as Herdman[5] pointed out, this connection between the duct of a gland and a pre-pharyngeal sense organ may be a secondary and purely accidental relationship.

The relative position of the neural gland, nerve-ganglion and dorsal tubercle is also of phylogenetic importance. The dorsally situated neural gland of *Herdmania*, which belongs to the Cynthiidæ, has thus far been found in only one other family of ascidians —the Botryllidæ. But Botryllidæ are compound ascidians and as such can have no direct relation with the Cynthiidæ, which are simple ascidians, according to Herdman's system of Tunicate classification[6] followed in most text-books of Zoology. On the other hand, the similarity in the dorsally situated neural gland points to a common origin of the Cynthiidæ and the Botryllidæ. A number of other examples from Herdman's system of classification show an unnatural separation of forms admittedly allied. *Clavellina* and *Diazona* are more similar in structure to *Ciona* than to *Coelocormus* or *Perophora*.[7] These affinities can be proved embryologically also. It is certain, therefore, that the compound ascidians are not a closely knit group of ascidians obtained from one common stock, but that they have evolved separately from different simple ascidian stocks to which they are more closely related than to other compound ascidians.

The author wishes to express his thanks to Dr. Sundara Raj of the Madras Fisheries Department for placing the resources of the Tuticorin Fisheries Station at his disposal for the collection of material. To Professor K. N. Bahl he is very much indebted for taking keen interest in the progress of the work and for valuable criticism.

[5] *Proc. Roy. Soc. Edin.*, 1883, **12**.

[6] *Journ. Linn. Soc. Zool.*, 1891, **23**.

[7] Garstang, *Rep. Brit. Assoc.*, 1895, 718-19.

Obituary.

Shiv Ram Kashyap (1882-1934).

RAI BAHADUR DR. S. R. KASHYAP, B.A. (Cantab.), D.Sc. (*Honoris Causa*, Panjab), I.E.S., F.A.S.B., Professor of Botany, Government College, Lahore, and of the Panjab University and Honorary Professor of Botany, Hindu University, Benares, died suddenly at Lahore, on the 26th November, 1934, of heart-failure. Even half an hour before his death, he was attending to his work with his characteristic thoroughness.

To-day his country is the poorer by the loss of one of its best-known and best-beloved intellectuals. As a scientist, he was respected all the world over and as a teacher he will be mourned by a host of admiring students all over the country, many of whom are holding University Chairs in Botany and other important appointments. For ever, he will be looked upon as one of the chief makers of modern Indian Botany. His pioneer researches on Himalayan Liverworts will go down to posterity as a great scientific achievement which will keep alive his memory for ever.

In his early life, Kashyap had a brilliant and remarkable academic career which can seldom be rivalled. Born on 6th November 1882 at Jhelum of a family with a long record of meritorious military services, he matriculated from the Panjab University in 1899. In 1900, he joined the Medical School at Agra and received his Medical Diploma in 1904, topping the list of successful candidates and winning the First Medal. He then served for two years in the Medical Service of the United Provinces.

While still a student of the Medical School he appeared as a private candidate for the Intermediate science examination

of the Panjab University and not only succeeded in passing the examination in the first division but stood at the top of the list in the University. He was offered a university scholarship but this he declined to accept and went on with his studies at the Medical School. In 1906, while serving in the Medical Department of the United Provinces, he again appeared as a private candidate for the B.Sc. examination of the Panjab University and again topped the list of successful candidates. In the same year he resigned his post in the Medical Service and was appointed Assistant Professor of Biology at Government College, Lahore. In 1909, he passed the M.Sc. examination in Botany, again getting a very high first class and standing first among the M.A. and M.Sc. candidates in the University. As a result he was awarded the much-prized Arnold and Maclagan Gold Medals of the University.

In 1910, he went to Europe and joined the Cambridge University from where, in 1912 he took his Honours Degree in the Natural Science Tripos.

On his return home, Professor Kashyap was appointed Professor of Botany at the Government College, Lahore, in the senior grade of the Provincial Educational Service and was promoted to the Indian Educational Service in 1920. In 1919, when the Honours School in Botany was organised by the Panjab University, he was appointed University Professor of Botany, in which capacity he continued to serve the cause of education until his death.

Dr. Shiv Ram Kashyap

He had been an elected Fellow of the University for many years and the Dean of the Science Faculty for a long time. He was also a member of the Syndicate and in 1931 officiated as Dean of University Instruction for some months. He had been for several years a member of the Science Faculty and of the Boards of Studies of several other Universities also, such as Agra, Lucknow and Benares. Professor Kashyap was the first systematic botanist to preside over the annual deliberations of the Indian Science Congress in 1932, ever since it was founded in the year 1914. It was the highest honour that the Indian scientists could confer on him. In recognition of his valuable contributions, the Panjab University, in 1933, conferred on him, *Honoris Causa*, the Degree of Doctor of Science.

He was the first secretary of the Indian Botanical Society, which was founded in 1920, and did all the spade work in its organisation. He was its President in 1925 and was the Editor-in-Chief of its organ, the *Journal of the Indian Botanical Society*. He was also an Advisory Editor of *Chronica Botanica*, published from Holland. He was elected President of the Botany Section of the Indian Science Congress in 1919 when the Congress met at Bombay.

He contributed numerous papers on various groups of the Vegetable Kingdom. His contributions to three subjects—the sexual generation of Equisetum, the Liverworts of the Western Himalayas and the flora of Tibet—however, stand out above all others. One of his very first papers appeared in 1919, in which he described the structure and development of the sexual generation of *Equisetum debile*, one of the Indian members of the family of horsetails, growing at Lahore, which was quite different from what was known up to that time in many species worked out by European and American investigators. The account was so different that some people even made adverse remarks in the beginning but later they all agreed when they saw the specimens. In 1917, Prof. Kashyap suggested that the sexual generation of other species would also show a similar structure as seen in the Indian species if certain conditions with regard to space and nourishment were fulfilled. Later work has shown how prophetic his prediction was.

The second subject of Prof. Kashyap's investigations has been the little group of

Liverworts or *Hepaticæ*. His contribution to the knowledge of the West-Himalayan Liverworts has been very great and this may be regarded as his chief subject. He described 4 new genera and over 30 new species of Liverworts. When his first paper on them was published Professor Goebel, of Munich University, one of the leading botanists of the World, wrote to him: "You have struck a gold vein in the Western Himalayas and made a most valuable addition to our knowledge of Liverworts." Professor (now Sir John) Farmer wrote, "I cannot refrain from congratulating you on the advance towards our knowledge of these interesting plants which you have been able to make."

His contribution to the Theory of Evolution by Reduction, in this group is very important and has been highly appreciated in Europe and America. He not only greatly expanded this theory and placed it on a strong basis but actually followed out the various lines of evolution. Dr. Cavers wrote to him, "I shall have to re-write the portion of 'Inter-relationships' dealing with the Marchantiales." Recently he published a monograph on the Liverworts of the Western Himalayas and the Panjab Plain. This is a very valuable piece of work and fills a great gap in the botanical literature of India.

The third subject to which Prof. Kashyap very largely contributed is the Flora of the Western Himalayas and Western and Central Tibet. He was a great traveller and probably knew more than anybody else about this interesting country. He crossed the Himalayas into Tibet at nine different places throughout its length and several times at some places. Among the regions visited by him are Ladak, the sources of practically all the rivers of the Panjab, the world-famous sacred country of Mountain Kailas and Lake Manasarovar, the sources of the Ganges and the Jumna, the country in the neighbourhood of Kanchenjunga, Gyantse, etc., etc. It may be said of him that he knew the Himalayas as one knows his own home. He brought back a very large collection of plants from these places, many of which have not been recorded from that country so far. Besides adding to the botany of these regions, he even extended their geographical knowledge. The exploration of the Himalayas and the study of its vegetation were his life's passion. It may not be known to all that years back when far out on the other side of the Himalayas, he fell ill and had to be brought down almost in an unconscious state. But that could not keep him back from further explorations in the following years. Last year, when up on the Himalayas, he again became seriously ill and had a bad attack of heart trouble. This year, he slightly recovered from its effects and was planning yet another trip to the Himalayas. With him, his work came first and if any one remonstrated with him for working so hard in his failing health, he would say "Why, my life is not more important than my work." Such was his love for his work. Those of us who had the rare good fortune of working with him as colleagues for a number of years look upon his death as a personal loss. A distinguished scientist, a pioneer botanist, a great teacher, and an indefatigable worker, an untiring Himalayan explorer, yes, he was all that but much more—he was, on top of everything else, a sincere friend and a generous helper to all his colleagues and pupils. Richly endowed with qualities of head, he achieved his tremendous popularity even more by his unique qualities of heart. He possessed in an extraordinary degree that sweet reasonableness which stamped him out at once as a gentleman and a man of true culture. All those who like me came in close personal contact with him, at once felt the subtle charm and magnetism and human warmth of his presence.

Such was the man who is deeply mourned to-day by a very wide circle of grief-stricken friends and admirers.

H. CHAUDHURI.

The following is a list of the publications of Professor Kashyap:—

(1) Notes on species of *Euglena* (*Records of the Indian Museum*, Calcutta, April 1908). (2) Structure and development of the Prothallus of *Equisetum debile* (*Annals of Botany*, London, January 1914). (3) Notes on New and Little-known West Himalayan Liverworts. No. 1 (*New Phytologist*, Cambridge, 1914). (4) Notes on New and Little-known West Himalayan Liverworts, No. 2 (*New Phytologist*, Cambridge, 1914). (5) Notes on New and Little-known West Himalayan Liverworts, No. 3 (*New Phytologist*, Cambridge, 1915). (6) The genus *Riccia* and the origin of the Pteridophytes (*Lahore Phil. Soc.*, June 1915) (*Proc.* for 1915-16). (7) Notes on *Targionia hypophylla*, (*New Phytologist*, Cambridge, 1917). (8) Notes on *Equisetum debille* (*Annals of Botany*, London, 1917). (9) Liverworts of the Western Himalayas and the Panjab Plain. No. 1 (*Jour. Bomb. Natur. Hist. Soc.*, 1916). (10) Liverworts of the Western Himalayas and the Panjab, No. 2 (*Jour. Bomb. Natur. Hist. Soc.*, 1917). (11) Notes on the inflorescence of *Zea Mays* (*Lahore Phil. Soc.*, June 1918) (*Proc.* for 1917-20). (12) Abnormal number

ot needles in the shoots of *Pinus longifolia* (*Jour. Ind. Bot.*, 1919). (13) Presidential Address to the Botany Section of the Indian Science Congress at Bombay in Jan. 1919 (*Proc. As. Soc. Beng.*, New Series, Vol. 15, 1919, No. 4, The relationships of Liverworts, especially in the light of some recently discovered Himalayan Forms). (14) The Androecium of *Plagiochasma appendiculatum* L. and *P. articulatum* Kash. (*New Phytologist*, 1919). (15) Variability in some Himalayan Liverworts (*Lahore Phil. Soc.*, February 1917) (*Proc.* for 1917-20). (16) Distribution of Liverworts in the Western Himalayas (*Lahore Phil. Soc.*, November 1919) (*Proc.* for 1917-20). (17) Floating Islands of Riwalsar (*Jour. Ind. Bot.*, April 1920). (18) Notes on the distribution of Liverworts in the Western Himalayas, Ladak and Kashmir (*Jour. Ind. Bot.*, May 1921). (19) Some observations on *Cycas revoluta* and *C. circinalis* growing in Lahore (*Jour. Ind. Bot.*, June 1921). (20) Notes on some Foreign Plants which have recently established themselves about Lahore (*Jour. Ind. Bot.*, December 1932). (21) A contribution to the Life-history of *Anzura indica* St. (*Jour. Ind. Bot.*, December 1922, jointly with S. K. Pande). (22) A long-lost Liverwort (*Monoselenium tenerum*), (*Jour. Ind. Bot. Soc.*, 1923). (23) Two Indian species of the genus *Notothylas* (*Lahore Phil. Soc.*, November 1923, Vol. 4). (24) Some abnormalities in the flowers of *Cannabis sativa* (*Jour. Ind. Bot. Soc.*, 1925, Vol. 4, No. 6). (25) Abnormal sporophylls in the male cone of *Cycas circinalis* (*Jour. Ind. Bot. Soc.*, Vol. 4, Nos. 9 and 10). (26) The Vegetation of Western Himalayas and Western Tibet in relation to their climate (*Jour. Ind. Bot. Soc.*, Vol. 4, Nos. 9 and 10, 1925). (27) The colour in the flowers of *Potentilla argyrophylla* (*Abs. Ind. Sci. Cong.*, 1926). (28) *Salsola fœtida* with special reference to its gal's (*Proc. Lahore Phil. Soc.*, Vol. 5, 1925-26). (29) Replacement of fertile shoots by vegetative shoots in *Euphorbia tibetica* Boiss. (30) A new species of *Petalophyllum P. indicum*, Kashyap, from Lahore (*Jour. Ind. Bot. Soc.*, 1928, Vol. 7, No. 1). (31) A study of *Dumortiera* (jointly with Mr. Brij Lal Sethi) (*Abs. Ind. Sci. Cong.*, Madras, 1929; Botany Section *As. Soc. Beng.*). (32) Observations on the flora of the Upper Chandra Valley and Spiti (*Abs. Ind. Sci. Cong.*, Madras, 1929, *As. Soc. Beng.*). (33) Some geographical observations in Western Tibet (*Jour. and Proc. As. Soc. Beng.*, 1929, Vol. 25, No. 1). (34) Liverworts of the Western Himalayas and the Panjab Plain, Part I (Panjab University Publication, 1929). (35) Liverworts of the Western Himalayas and the Panjab Plain, Part I, Supplement (Panjab University Publication, 1933). (36) Liverworts of the Western Himalayas and the Panjab Plain, Part II (Panjab University Publication, 1933). (37) The Liverwort flora of Sikkim, Read at the Ind. Sci. Cong., Allahabad, January 1930 (*As. Soc. Beng.*, Bot. Section). (38) Notes on the flora of Central Tibet, Read at the Ind. Sci. Cong., Allahabad, January 1930 (*Abs. Bot. Sec., As. Soc. Beng.*). (39) Some abnormal cones in *Equisetum debille* (*Jour. Ind. Bot. Soc.*, Vol. 9, No. 4). (40) Some peculiar cones and microsporophylls of *Cycas circinalis* (*Jour. Ind. Bot. Soc.*, Vol. IX, No. 4). (41) *Stellera chamæjasme* Linn. (*Jour. Ind. Bot. Soc.*, 1930, Vol. IX, No. 4). (42) Acrogynous Liverworts of the Western Himalayas (*Malaviya Commemoration Vol.*, 1932). (43) Some aspects of the Alpine vegetation of the Himalaya and Tibet with appendix—List of plants in the Herbarium of the Botany Department, Government College, Lahore, collected by Prof. S. R. Kashyap beyond the main Himalayan range, Pres. Address to the Nineteenth Indian Science Congress at Bangalore (*Proc. of the 19th Ind. Sci. Cong.*, 1932). (44) Autonomous movement in the leaves of *Curculigo recurvata*, Dryand. (*Current Science*, Vol. I, No. 1). (45) Some more peculiarities in the male cone of *Cycas circinalis* collected at Lahore in 1932 (*Ind. Sci. Cong.*, Patna, 1933, Abs.) (46) An account of a Journey to the Gangotri Glacier (*Urusvati Journal*, 1933). (47) Jointly with P. N. Mehra. Dichotomous branching in the leaves of *Pteopeltis simplex* Sw. (*Current Science*, 1934. Vol. III, No. 2). (48) Flora of the Central Panjab (To be published shortly by the Panjab University).

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Dr. Ekendranath Ghosh, M.Sc., M.D.

WE regret to announce the untimely death of Dr. Ekendranath Ghosh, M.Sc., M.D., Professor of Biology, Medical College, Calcutta, at the age of 50, on the 15th of October, at his Calcutta residence. Dr. Ghosh was a distinguished graduate of the Calcutta University and was appointed as the Professor of Biology in 1917. He was not only a distinguished Biologist and Physician, but was vastly read in Sanskrit Ayurveda and Hindu Astronomy and published valuable contributions in all these subjects. One of his important papers that appeared four days before his death is reviewed in another place in this issue. His death is mourned by a large circle of his friends and pupils.

Letters to the Editor.

Note on the Limiting Density, Mass and Temperature of Condensed Stars.*

IN a previous note[1] it has been shown that with electrons degenerate stellar matter is completely ionised for number density ~ 10 and temperature ~ 10. Thus the stability of highly condensed stars is maintained by the equilibrium between the gravitational pressure (or energy) and material kinetic and radiational pressure (or energy). Besides these, electrostatic energy is also to be introduced. While Fowler and Frenkel[2] neglect this last factor, Kothari[3] holds that this causes an appreciable increase in the limiting density. The kinetic energy of the positive ions has also been neglected by most workers. We propose to reconsider the effects of the electrostatic energy, kinetic energy of the positive ions and the radiational energy on the limiting density, and temperature of Stars.

Electrostatic Correction.—In the case of completely ionised atoms electrostatic energy corresponds to the total ionisation potential which has been calculated by Sommerfeld[4] for a Fermi atom. Taking the total number of atoms $n = \frac{M}{2 \cdot 5 m_H}$; M being stellar mass and 2·5 the average mol. wt. For iron atoms $E_s = 1 \cdot 597 \times 10^{14} M$. Introducing this value in the equation of equilibrium: $2T = W_s + W_e$ the kinetic energy of electrons for the non-relativistic degenerate case being taken we find that electrostatic correction is negligible as suggested by Fowler. The results are tabulated below :—

Star	M/M	$n \times 10^{29}$	$n_0 \times 10^{29}$	%correction
Sun ..	1	9·588	9·561	0·28
Sirius B ..	1·18	6·474	6·59	0·25
Eridani ..	2·27	1·744	1·726	1·04

Effect of the Kinetic Energy of Positive ions.—K.E. of positive ions $= \frac{3}{2} NkT = 4 \cdot 955 \times 10^{7}$ T.M. Thus this is comparable to that of electrons even for n. If, however, equilibrium be considered at absolute zero then it is zero. Modified values of n due to this are entered below :—

Star	Temp.	$n \times 10^{29}$	$n_0 \times 10^{29}$	%correction
Sun ..	10^6	9·594	9·561	0·34
Eridani ..	10^8	2·733	1·726	36·4
Sirius B ..	10^8	8·106	6·459	12·5

Effect of Radiation Pressure.—As pointed by Jeans radiation pressure exerts a marked influence on the hydrostatic equilibrium especially for a condensed star. If we consider the following condition for stability $P_0 + P_R \not> \frac{3}{8\pi} \times \frac{GM^2}{R^4}$ we can calculate the modification in the limiting density.

Relativistic Case.—For the relativistic case which is valid for $n > > 5 \cdot 932 \times 10^{29}$ the K.E. of electrons is $7 \cdot 243 \times 10^{-17} n^{4/3}$. On introducing this into the equation we obtain a critical mass $\frac{M}{M_s} = 0 \cdot 2787$ above which equation is not valid. Frenkel introduces the K.E. of positive ions and obtains the limiting density $\sim 10^{21}$. His method is, however, faulty as he assumes a maximum pressure p'_0 for the statistical distribution of positive ions given by the relation $\frac{p_0}{p'_0} = \left(\frac{n}{n'}\right)^{1/3} = Z^{1/3}$ where p_0 is the maximum pressure for electron distribution according to Fermi statistics. He thus tacitly assumes positive ions to be degenerate.

Modifications in the limiting density for a given star due to the K.E. of positive ions and radiation pressure can be calculated. One can also calculate the maximum temperature for a given star with given density and mass by introducing the K.E. of electrons alone or by taking into consideration the K.E. of the positive ions as well.

A. GANGULI.

College Dupleix,
Chandernagore,
November 1934.

* Abstract of a paper read in the Inaugural Meeting of the Indian Physical Society.

[1] Ganguli, *Curr. Sci.*, Dec. 1932, **1**; 1934, **2**, 294.

[2] Fowler, *M.N.*, 1926, **87**, 114; Frenkel, *Z. Phys.*, 1929, **55**.

[3] Kothari, *Phil. Mag.*, 1931, **12**, 672; see also Stoner, *M.N.*, 1932, **92**, 651.

[4] Sommerfeld, *Z. Phys.*, 1933, **78**,

Formation of Hydrates and Diamagnetism.

A STUDY of the diamagnetic susceptibilities of liquid mixtures has shown that magnetic measurements are not sensitive to interaction

effects whether between like or unlike molecules carrying high dipole moments.[1] In some cases, even the formation of a compound does not affect the electronic configuration sufficiently to produce appreciable changes in susceptibility. We need cite only the cases of acetic acid and stannic chloride and of ethyl formate and stannic chloride investigated by Kido.[2] As a natural extension of these investigations, a study was made of the influence of the formation of hydrates on diamagnetism.

Cabrera and Fahlenbrach,[3] using aqueous solutions of potassium iodide observed changes in the magnetic susceptibilities due to different degrees of hydration; they also inferred that there was greater hydration at higher temperatures and that an increase of diamagnetic susceptibility resulted due to greater ionic deformation. In view of the fact that hydrates in general tend to break up on heating, such an influence is quite unlikely. This view has also been recently advanced by Tammann.[4]

Measurements on acetic acid-water mixtures failed to indicate any changes in diamagnetic values at equimolecular concentrations of the components, although a definite compound has been proved to exist particularly by Raman effect[5] and viscosity measurements.[6] As was mentioned in an earlier paper[1] in connection with acetone-chloroform mixtures, the deviation of nearly 12% observed by Sibaiya and Venkataramiah[7] seem to have also been caused by viscosity effects in their experiments.

The decahydrate of sodium sulphate was studied both in the solid state by the Curie method and in concentrated solutions by the Quincke method. When the hydrate was heated to temperatures over 33°C. (at which temperature the water of crystallisation breaks away and the salt becomes anhydrous) no change of magnetic susceptibility was observed.

Aqueous solutions of sulphuric acid, however, indicated definite deviations from additivity at concentrations of the mixture corresponding to $2H_2SO_4$, H_2O; H_2SO_4, H_2O; H_2SO_4, $3H_2O$; H_2SO_4, $6H_2O$ and H_2SO_4, $18H_2O$. The first hydrate gave an increased value while the others showed negative deviations. The deviations were of the order of 3 to 4%. These hydrates are also indicated by other physical properties such as electrical conductivity, viscosity and surface tension.

The diamagnetic susceptibilities of crystalline sulphates of Li, Na, K and Mg were determined in the solid state by the Curie method. The ionic susceptibilities of Li^+, Na^+, K^+ and Mg^{++} calculated from the magnetic values of the hydrated salts, assuming the validity of the additive law, agree satisfactorily with the precision values of Joos,[8] Kido,[9] Ikenmeyer[10] and Pascal.[11] This suggests that the binding of the water molecules to the sulphates is very loose in contradistinction to the case of the hydrates of sulphuric acid. This conclusion receives support from the well-known fact that while sulphuric acid has a great avidity for water, the other sulphates lose their water of crystallisation very easily. Under these circumstances, the results of Ray Chaudhuri[12] seem doubtful.

It may therefore be concluded that there is not much theoretical support from these data for the concept of the enlargement of ionic radii with increased temperature in solution.

Full results will be published elsewhere.

S. RAMACHANDRA RAO.
P. S. VARADACHARI.

Annamalai University,
Annamalainagar,
December 2, 1934.

A Preliminary Note on the Chemical Examination of the Roots of *Citrullus colocynthis* Schrader.

Citrullus colocynthis, called Indrâyan in Hindustani, is a plant used in medicine for a very long time. The fruit of this plant has been chemically examined by Power and Moore* in 1910. The roots are described by the Sanskrit writers as a useful cathartic in

[1] *Proc. Ind. Acad. Sc.*, 1934, **1**, 77.
[2] *Sci. Rep. Tohoku Imp. Univ.*, 1932, **21**, 385.
[3] *Zeits. f. Phys.*, 1934, **89**, 166.
[4] *Ibid.*, 1934, **91**, 410.
[5] *Ind. Jour. Phys.*, 1931, **6**, 401.
[6] *Jour. Chem. Soc.*, 1909, **95**, 1556.
[7] *Ind. Jour. Phys.*, 1932, **7**, 393.
[8] *Zeits. f. Phys.*, 1923, **19**, 347.
[9] *Sci. Rep. Tohoku Imp. Univ.*, 1934, **22**, 835.
[10] *Ann. der Phys.*, 1929, **1**, 169.
[11] *Comp. Rend.*, 1921, **173**, 144.
[12] *Zeits. f. Phys.*, 1932, **77**, 271.

* Power, F. B., and Moore, C. W., *Jour. Chem. Soc.*, 1910, **47**, 99.

jaundice, ascites, enlargement of the abdominal viscera, urinary diseases and rheumatism, etc. They are also supposed to have a drastic purgative action.

2 kilograms of the powdered roots were exhaustively extracted with boiling alcohol. The concentrated extract on standing deposited a white crystalline stuff, which on recrystallisation from alcohol melted at 230° C. The mother liquor was then evaporated to dryness and extracted with petroleum ether. This petroleum ether extract on concentration gave a small amount of a white sediment, which on purification melted at 68° C. From its properties and reactions it was identified as hentriacontane $C_{31}H_{64}$.

The resinous mass left after the treatment with petroleum ether, was then extracted with ethyl acetate. The ethyl acetate extract on evaporation of the solvent under reduced pressure yielded a white deposit which was filtered. On recrystallisation from ethyl alcohol it melted at 230° C. From its properties, reactions and elementary analysis it was identified as α-elaterin. This was the same stuff as that obtained from the alcoholic extract in the beginning. The percentage was 0·2 per cent. of the dried weight of the roots. (Found C=69·0, H=7·5; $C_{28}H_{38}O_7$ requires C=69·1, H=7·8 per cent.). The diacetyl α-elaterin $C_{32}H_{42}O_7$ was prepared in the usual way and crystallised from acetic acid. It melted sharp at 123-124°.

The brown stuff of the dried alcoholic extract, left after the removal of the α-elaterin by ethyl-acetate was then dissolved in boiling water and treated with basic lead acetate when an yellow precipitate was obtained. It was filtered, washed, suspended in water and decomposed by H_2S. The resultant filtrate, after the decomposition of the lead salt, on concentration, *in vacuo* gave all the reactions of the saponins. All attempts to isolate this in a pure form have failed uptil now.

The physiological properties of the drug appear mainly due to the presence of α-elaterin. A detailed account of the work will be published elsewhere.

R. R. AGARWAL.
S. DUTT.

Chemical Laboratory,
Allahabad University,
November 19, 1934.

Mannose Dehydrogenase and Ascorbic Acid (Vitamin C).

WE have for some months been carrying out an investigation on the nature of the precursor and mechanism involved in the synthesis of ascorbic acid by the rat, which is known to be independent of an external supply of the vitamins. It has been found from incubation experiments with the isolated liver, spleen and kidney tissues of the rat at 37° in a medium of Ringer-Locke solution and phosphate buffer at pH 7·4 that these tissues are able to convert mannose but not glucose, fructose, galactose, xylose and arabinose, into ascorbic acid, as determined titrimetrically.[1] Amounts of the order of 0·30—0·35 mg. of ascorbic acid have been formed from mannose per gramme of each of these tissues after 3 hours' incubation. It has been possible, further, to separate to some extent the mannose dehydrogenase system, responsible for the dehydrogenation of mannose into ascorbic acid, by extracting the acetone-dried tissues (liver, spleen and kidney) with water. The cell-free extract from liver is able to produce 0·07 mg. ascorbic acid from mannose per gramme of the tissue under the aforesaid conditions. The tissues, after being washed once with Ringer-Locke solution in order to remove the normal substrates present, are also able to synthesise ascorbic acid from mannose. The apparently specific behaviour of mannose, among the sugars studied, in this respect is under further investigation.

In contradistinction to the rat, the corresponding tissues of the guinea-pig (which is dependent on an outside source of vitamin C), both normal and scorbutic, have been found to be unable to convert mannose (or any of the other sugars mentioned above) into ascorbic acid.

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A. R. GHOSH.

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November 28, 1934.

Haustorial Regeneration of Sandal (*Santalum album*, Linn) and Its Significance.

THE regenerative ability of plant tissues varies with different species of plants. While some plants can be propagated only through

[1] Guha and Ghosh, *Cur. Sci.*, 1934, **2**, 390.

seeds, there are others where asexual or vegetative modes of propagation are possible and offer quicker methods of establishing stocks in plantation or sylvicultural practice. They are particularly welcome in the case of slow growing species like sandal which have great economical value. Sandal lends itself to stump planting and if carried out in the monsoon season, a fifty per cent. success can be obtained.

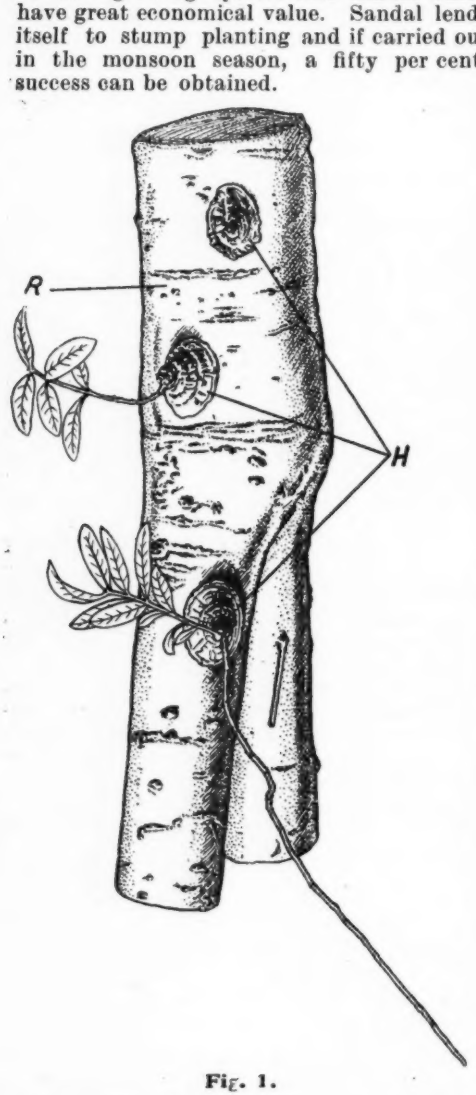

Fig. 1.

Sandal can also be propagated through root suckers; when a sandal tree is trenched at a distance of about 5 to 6 ft., it is common to find root suckers sprouting up from both faces of the trench. A larger number of them come out of the outer surface thereby indicating that a root disconnected with the parent tree is capable of regeneration. Experiments in the nursery under controlled conditions showed that one of the essential conditions that appears to be necessary for the success of such a type of regeneration, is that the decapitated root should maintain its haustorial connection with its host plant. The regenerative ability of root suckers is therefore closely associated with the haustorial connection, a fact convincingly brought out by Fig. 1, emphasising the physiological independence and parasitic character of the haustorial connection. The illustration is the drawing of a specimen of *Pongamia* root R exposed by soil erosion on the bank of a water-way near Uttarahalli. At the time of observation, the root was not in connection with any sandal plant but the haustorial connections H were intact. A few weeks later, the haustorial connections sprouted giving rise to sandal shoots.

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December 6, 1934.

Relative Parasitism of the Cotton Root-Rot Organisms from Gujrat Soils.

AMONGST the organisms isolated from affected roots of cotton, the principal ones are: (1) *Fusarium vasinfectum* form, (2) *Macrophomina* sp. (*Rhizoctonia bataticola*), (3) a species of *Cephalosporium*, and lastly, (4) a *Cephalobus* species of nematodes. Of these the *Cephalosporium* occurs rarely and there is no evidence to show that it is a parasite. The *Fusarium vasinfectum* form has been shown to be non-pathogenic. Under any circumstances this form of *Fusarium* has not given any infection and this observation has been confirmed by another worker from a wilt research laboratory to whom this form was sent. *Fusarium* obtained from Jalgaon and Broach as also the one from Desan, a village in Baroda territory, where wilt exists, gave a high percentage of infection.

It may be noted from Fig. 1 that the Desan fungus was a fresh culture (pot Nos. 3-4), whereas the fungus used in pots 1-2, 5-6 was from Jalgaon and Broach wilt areas respectively and isolated from the *gorat* soils from Baroda infected for the third time.

Fig. 1.

Infections with *Fusarium vasinfectum* form from wilt and rot soils.—(1) Jalgaon, 9 plants—3 deaths. (2) Jalgaon, 12–1, (3) Desan, 10–10, (4) Desan, 11–8, (5) Broach, 6–1, and (6) Broach, 9–0.

The fresh Desan fungus is very virulent as compared to the other two, which have lost their infective property due to their having remained for two generations in *gorat* soil.

Nematodes are generally symbiotically associated with this *Fusarium* Baroda form. No culture of the nematodes could be obtained free from the fungus although the fungus could be cultivated free from nematodes by dropping the worms in a liquid culture medium. It was thus quite probable that the existence of this *Fusarium* in affected plants was due to these nematodes.

The more closely associated rot organisms were thus the nematodes and *Macrophomina* sp., the parasitism of which could not always be induced under ordinary circumstances, although some evidence to that effect has been obtained. An interesting observation on the May and monsoon-sown cottons led to the discovery of the conditions favouring parasitism. A survey of the rot incidence made in the beginning of this Scheme on 1931-32 cotton crop from the Agricultural Experimental Station at Baroda indicated that rot occurs more extensively in the May-sown irrigated cottons as compared to those sown in monsoon after the first showers (Fig. 2).

Plot No. 22 (see graph) was sown on 15th of May 1931 and irrigated with well water seven times; this shows a rot percentage of 92 whereas with the monsoon-sown crop the percentage lies between 23 to 58. These latter plots were sown between the 18th and the 19th June, after the first showers which occurred on the 16th June 1931. Total precipitation for the year amounted to 55·60 inches. The only difference between the May and June sown crops lay in the conditions of irrigation, soil humidity and temperature. After the first showers the conditions were identical for both the crops.

Regular meteorological data were collected from April 1932 and an examination of these showed that a soil moisture of 30 per cent. and a temperature of 40° C. favoured parasitism in *Macrophomina* and *nematodes* jointly, although each one was capable of becoming parasitic under identical conditions.

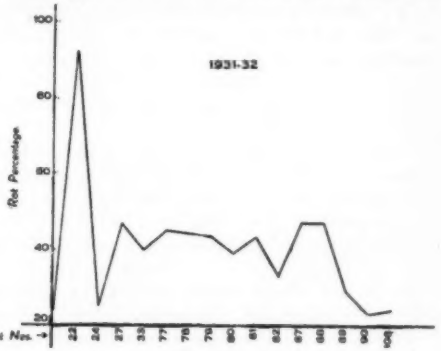

Fig. 2.

Experiments in which the organisms enjoyed these conditions were, therefore, planned in order to find out whether such conditions are conducive to infection. The methods employed were as follows.—

1. Roots of rot-affected cotton plants were cut into pieces, the bark being peeled off. This material was mixed up with sterilised soil and incubated for eight days after which delinted seed was sown. The temperature ranged between 38°—40° C. Within a month from sowing, out of a total of 25 seedlings 13 died of rot from which *Macrophomina* and *Nemas* were isolated. Controls from temperature tanks and rooms did not produce any deaths.

2. Roots from affected plants were chopped into pieces and mixed with sterilised soil. These were incubated for eight days in a multiple incubator with a range of temperature between 27°—42° C. Out of 41 seedlings 39 died of rot. Death roll ranged high between 30°—42° C. and isolations gave pure *Macrophomina* and *Nema* cultures.

3. Sterilised soil was mixed up with healthy cotton stalks and autoclaved. Cultures of *Macrophomina* and *Nemas* on cotton stalks were used. Infections were done with individual organisms and mixtures. Controls were kept in temperature tanks and at room temperature. The temperatures in the tanks ranged between 38°–40° C. Three out of the 15 seedlings from *Macrophomina*-pot and three out of 9 seedlings

from *Nema*-pot succumbed, and from the mixture one out of 9 died after a lapse of one month. Isolations gave identical organisms from dead plants.

4. Only *Macrophomina* was used in the same manner with two controls. Temperatures of the tanks ranged between 35°—42° C. Out of the 25 seedlings from 5 pots 14 died of rot from one tank and out of the 23 from the second tank 8 died after a lapse of one month. Isolations gave pure cultures of *Macrophomina* and there were no deaths in the controls.

The infective capacity of *Macrophomina* and *Nema* became established thus under certain temperature and humidity conditions of the soil. No sooner these conditions disappear the organisms tend towards saprophytism in the soil (see Fig. 2).

In all the above experiments water from the well with pH 8 was used. The tendency of the *Fusarium vasinfectum* form (pH 5·4) being towards acidity while that of *Nema* and *Macrophomina* was towards alkalinity as observed from cultural filtrates (pH 7·6—8·0). The soil reaction ranged from neutral to alkaline and compares with the pH ranges for the two infective organisms. The action of the irrigated water as compared to the rain water may also be taken into consideration.

In view of the results obtained, in addition to the study of resistant and immune strains to rot, control measures are being developed, involving soil disinfections, manurial and change of sowing date trials.

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November 3, 1934.

On the Introduction and Spread of *Euphorbia geniculata*, Orteg. in South India.

IN June 1933 I found several specimens of a species of *Euphorbia* growing in cultivated ground in Kengeri (9 miles from Bangalore). A little later I found the same plant growing as a weed in Bangalore. Being unable to identify it with the help of Indian floras I sent specimens to the Calcutta Herbarium and to Kew. Both Mr. Biswas and Mr. Fischer identified the plant as *Euphorbia geniculata*, Orteg. a native of Tropical America.

After making numerous enquiries I eventually came across an old gardener in the Government Gardens at Bangalore who told me that he clearly remembered that when Mr. Stephen first came to the Lalbagh he brought with him a pot of this plant and another containing a variety of *Capsicum*. Both plants grew well and set seed in Bangalore. The *Capsicum* became a popular garden plant for some years but appears to have now died out. The *Euphorbia* was also planted in gardens and soon established itself as a garden escape. Mr. Fischer tells me that Mr. John Horne Stephen came out to the Lalbagh gardens from Kew in 1891 as Assistant to Mr. John Cameron but soon left having obtained the appointment of Superintendent of the Government Gardens, Nagpur.

Euphorbia geniculata is a pretty plant suitable for edging in gardens although the original scarlet coloration of the leaves has been lost except occasionally when it grows in exposed situations. It produces enormous numbers of minute seeds and its spread is doubtless due to this fact. It cannot at present be regarded as a serious pest but it is becoming a troublesome weed in gardens and cultivated land.

With Bangalore as its starting point this plant has proceeded in various directions over many miles of Mysore State. It has advanced to Devanahalli on the north and to Hoskote on the north-east. On the east it has proceeded to Whitefield and on the south-east to Anekal. It has gone as far as Kankanhalli on the south and to the hamlet of Gangenhalli on the west. On the old Madras road it has reached the British town of Hosur. Last May I saw it established at Nanjangud, over one hundred miles from Bangalore. Recently it has made its appearance in the city of Madras, having established itself on a piece of vacant land near to the Government Royapettah Hospital.

The leaves of *Euphorbia geniculata* have been widely known as a purgative for many years among the poorer classes in and around Bangalore. The credit of the discovery goes to a gardener in Bangalore who in the earlier years of its introduction ate it as a pot-herb and experieneed violent purging as a result. It is interesting to note that even to-day this purgative is taken always mixed with food.

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Madras,
November 19, 1934.

The Original Home of *Achyranthes aspera* L.

IN a recent paper, Joshi[1] has described some variations in the behaviour of the two medullary bundles in the stem of *Achyranthes aspera* and has tried to trace the original home of the plant from the variations he observed. The latter part of the paper appeared interesting to me and I thought of putting his amazing suggestions to a test.

Twenty plants were thoroughly examined from top to base. They provided 208 internodes, each of which was cut at three places—top, middle and base. Most of the sections were examined under the microscope.

Out of the internodes examined, only 12 showed a single amphixylic bundle in the lower half, while in the upper half the two bundles were quite free. In one internode the upper half showed a single amphixylic medullary bundle, while the lower half showed two free normal bundles. In yet another internode there was a single amphixylic bundle running throughout its length.

Apart from these 14 internodes, all the rest, out of a total of 208, showed two free medullary bundles throughout their length.

Now, geographically Agra is situated between Benares and Lahore. Therefore, if Joshi's hypothesis is correct, the majority of the internodes in the Agra plants should show a fused condition of medullary bundles, which is not actually the case as the above figures show.

I may point out one probable source of error in his observations. That he did not use the microscope as frequently as is needed is amply clear from the fact that he examined most of the material "on the spot" after "cutting it with a safety-razor blade". I have observed that in a large number of cases, the medullary bundles approach each other so closely as to appear to have fused. But a section under the microscope reveals that they are free.

I have also observed the following exceptional conditions not mentioned by Joshi:

(i) Out of the two medullary bundles, one is normal while the other is amphixylic.

(ii) A single normal medullary bundle takes the place of the usual two.

In the end I would humbly submit that the facts in nature are usually not so easy to explain, and a hasty conclusion makes the confusion worse confounded. To build the whole edifice on a lean foundation is more than desirable.

B. L. GUPTA.

Department of Botany,
Agra College, Agra,
October, 1934.

[1] Joshi, A. C., "Variations in the medullary bundles of *Achyranthes aspera* L. and the original hom of the species." *New Phyt.*, 1934, **33**, 53–57.

A Fossil Dicotyledonous Wood from Assam.

IN December 1933, Mr. C. S. Purkayastha of the Assam Forest Service sent to the Forest Research Institute, Dehra Dun, two pieces of fossil wood for identification. These he had collected from Dhansiri Reserve in Nowgong Forest Division, near Nailalung Railway Station, about 20 miles from Lumding Junction (A. B. Railway). On superficial examination both specimens were found to be secondary wood of dicotyledonous tree but entirely different from one another. The object of this note is to put on record the identification of specimen No. 2.

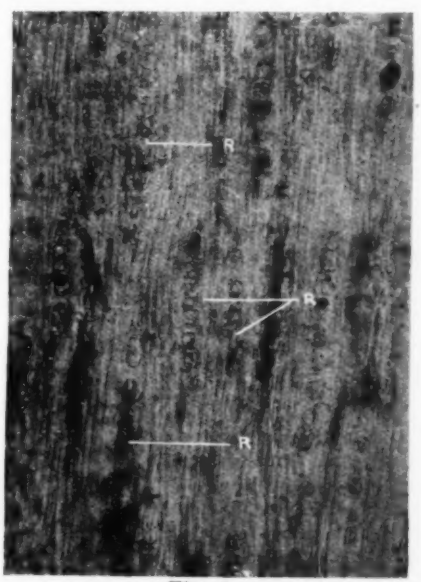


Fig. 1. × 150

Tangential section showing uniseriate rays (R.)

The specimen is not very large. It is somewhat circular in cross section, the diameter being 5 inches and the length

8 inches. From the look of the specimen it seems to be a portion of a fairly big trunk. Its preservation is very bad and uneven. On the longitudinal surfaces black stripes are observed indicating disintegration of the woody tissues in some places.

A good many sections (cross, tangential and radial) were cut and mounted in the usual manner. Although these sections were far from perfect, yet it was possible to find in them the minute anatomical structure essential for the identification of the wood. Moreover, macerated material

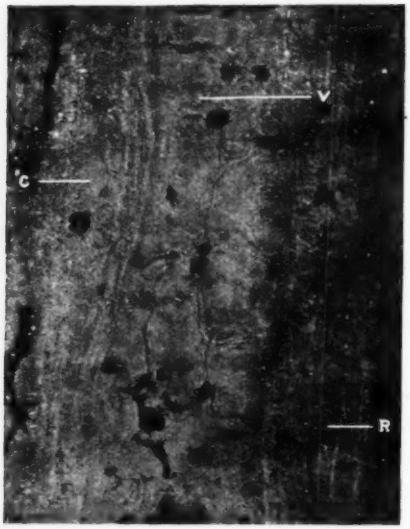


Fig. 2. × 230

Tangential section showing triseriated ray with resin canal (C.) in the middle, vessel (V.) with tyloses and uniseriate rays (R.)

of the wood was obtained in a sufficiently good state of preservation to enable a study of the pits on the walls of the vessels, fibres and parenchyma cells. The anatomical structure of the fossil wood may be summarised as follows :—

It is a diffuse-porous wood with mostly medium-sized vessels, which are heavily tylosed and filled with brownish deposits. Parenchyma cells are vasicentric and in narrow metatracheal bands, which may run to a considerable distance across the rays, or may end abruptly after running a short distance. The rays are of two types: (i) uniseriate, (ii) 3-4 seriate. The latter type is fusiform and contains horizontal resin canals which are rather small in size. In these features as well as in the pits, the fossil wood shows great similarity to the woods of *Gluta* species of the Anacardiaceæ. The name *Glutoxylon assamica* is, therefore, proposed. Details of the geological formation in which the fossil wood was found and a description of the minute anatomical structure of the wood itself will be published elsewhere.

K. A. CHOWDHURY.
Forest Research Institute,
Dehra Dun, U.P.,
October 4, 1934.

Abnormal Flowers of *Cassia fistula* Linn.

AN examination of a large number of flowers of *Cassia fistula*, with a view to collecting some data regarding the occurrence of polyphylly[1] in the gynoecium of the flowers of the species, which was noted some time last year, revealed the existence of the following types of abnormalities.

1. *Median floral prolification.*[2]—In cases recorded by Masters (vegetable teratology), the prolonged axes have been terminated by a flower bud. In this case, the axis has grown into an inflorescence, bearing a number of buds in a racemose manner.

2. *Axillary floral prolification.*—A normal flower occurs in the axil of one of the anterior sepals. Associated with this is the suppression of two of the ten stamens.

3. Besides prolification, polyphylly of the various floral whorls was also met with. Polyphylly of the gynoecium (in a few cases upto seven carpels) was most frequently seen. In only one case was there a multiplication of all the floral whorls. In others, the polyphylly of any particular series (calyx, corolla, androecium, etc.) was unaccompanied by any proportionate multiplication of the rest of the floral parts.

Figures, and a more detailed account of the abnormalities will be published elsewhere.

T. S. RAGHAVAN.
K. R. VENKATASUBBAN.
Annamalai University,
Annamalainagar,
S. India,
November 27, 1934.

[1] *Polyphylly.* Members of any particular whorl are increased in number.

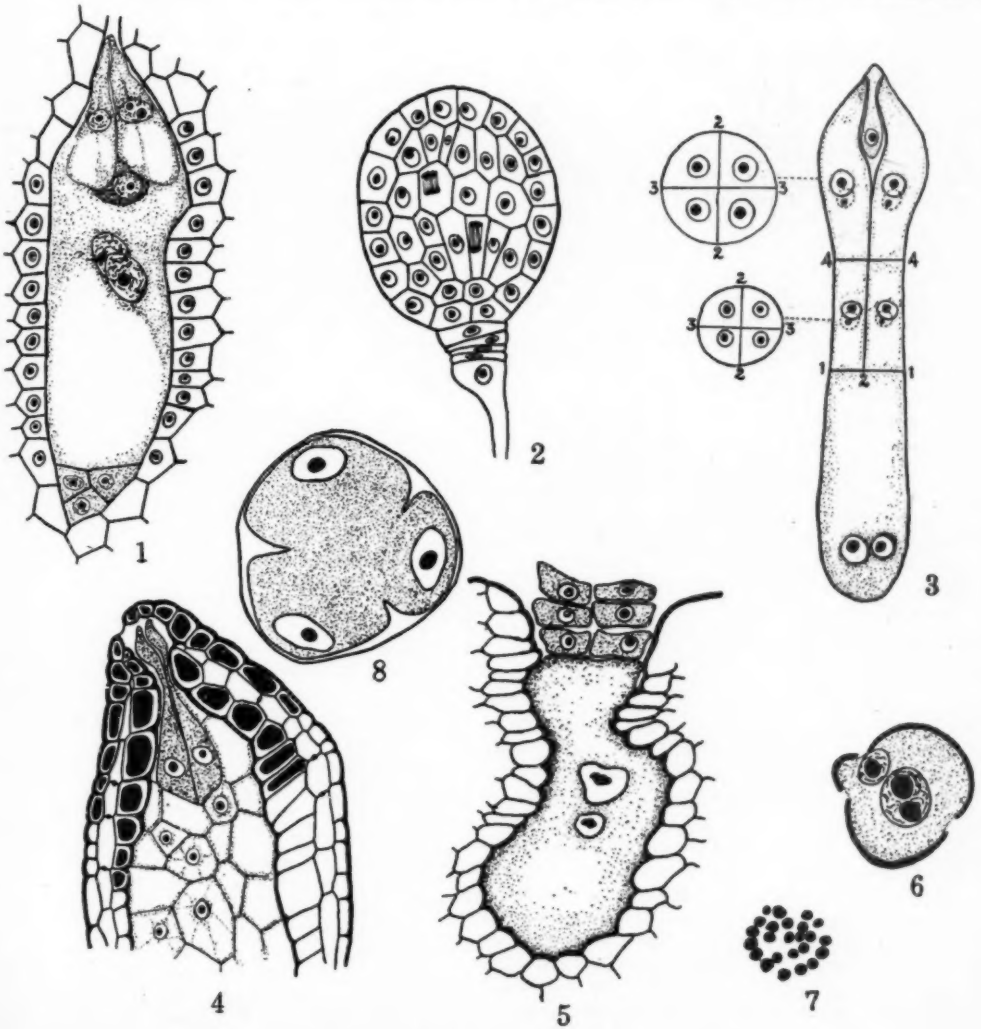
[2] *Prolification* is the production of buds either in the centre of the flower or axillary to some of the floral leaves.

Life History of *Herpestis monniera* H. B. & K.

THE embryo sac of the *Scrophularineæ* is a subject of unabated interest and a large volume of literature has grown around it in recent times. On the other hand, a detailed cytological account is conspicuously absent in the available literature. The present paper represents a summary of the results of an investigation embodying the cytology of the pollen mother cell, the development of the embryo sac, embryo and endospermal haustoria in *Herpestis monniera*.

The material for study is a fairly abundant weed around water margins in Bangalore and is in flower practically throughout the year.

The meiotic phenomena in the pollen mother cell and the megaspore mother cell have been followed in detail especially in regard to the chromosome behaviour. The mode of pairing of chromosomes is found to be parasynaptic. A process of simultaneous



Figs. 1 to 8.

quadripartition by gradual centripetal furrowing results in the organization of the tetrads of pollen grains (Fig. 8). Twenty-four bivalents have been counted in the polar view of the heterotypic metaphase (Fig. 7). The pollen grains at the time of shedding are binucleate (Fig. 6).

The bilocular ovary is placed in a median position in the flower and has massive axile placenta bearing indefinite number of anatropous ovules all round except at the apex. The hypodermal archesporial cell is directly transformed to the megaspore mother cell without a periclinal wall. The chalazal megaspore of the linear tetrad grows into the eight-nucleate embryo sac (Fig. 1). The organization of the uninucleate embryo sac is coincident with the disintegration of the nucellar tissue. The mature embryo sac is thus in intimate contact with the innermost layer of the cells of the integument. This layer forms a nutritive tapetum and has been known as either the tapetum or epithelium.

Two male cells are organized in the growing pollen tube. Double fertilization has been observed. Syngamy is effected in a resting condition. The two polars are completely fused by the time the male nuclei are discharged into the embryo sac.

The first division of the primary endosperm nucleus is immediately followed by a transverse wall resulting in a chambered embryo sac. The nucleus of the lower chamber divides once with no wall-formation. This chamber develops into the chalazal haustorium. The upper chamber, in addition to contributing to the entire endosperm forms a micropylar haustorium with four uninucleate lobes. The micropylar haustorium is very aggressive and persists even in the seed, the tips projecting out of the integument (Fig. 4). The chalazal haustorium is short-lived and disintegrates early (Fig. 5). (The formation of the endosperm and the haustoria is indicated in diagram 3.)

A long period of rest intervenes after fertilization and when the endosperm has attained considerable dimensions the fertilized egg undergoes division. The one-celled embryo is fairly long. The embryogeny conforms to the Capsella-type with this exception that the first cell of the suspensor after giving rise to the hypophysis undergoes a number of transverse divisions. The suspensor disintegrates early (Fig. 2).

Thanks are due to Dr. M. A. Sampathkumaran for guidance and criticism.

K. V. SRINATH.

Department of Botany,
Central College,
Bangalore,
November 19, 1924.

Gametogenesis and Embryogeny in Some *Commelinaceæ*.

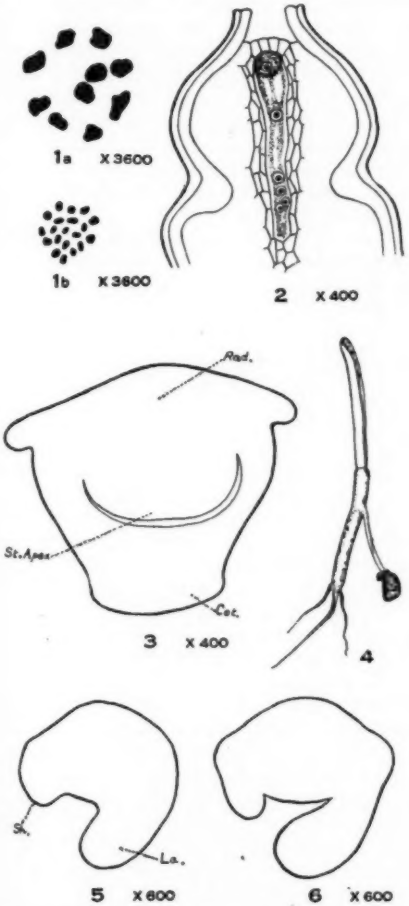
THE salient observations made by the writer on *Cyanotis cristata* Schlf., *Cyanotis axillaris* R. & S., *Aneilema spiratum* R. Br., and *Zebrina pendula* Schn. are given here, the details being treated in the full paper to be published elsewhere. Unlike in *Commelina benghalensis* Linn., none of the above-mentioned plants produce any cleistogamous flowers.

A T-shaped tetrad of megaspores is formed in *Aneilema spiratum*. No wall is formed between the two megaspore nuclei in the micropylar daughter cell in the case of *Zebrina pendula*. In *Cyanotis cristata*, the mature embryo sac is restricted to an upper dome-like portion of the ovule formed by the development of a circular constriction, the micropylar collar (Fig. 2). The antipodals are ephemeral in all the plants studied. After fertilisation, the narrow antipodal end of the embryo sac of *Cyanotis cristata* pierces deep down into the nucellus as a haustorium, which is occupied by some of the first formed free nuclei of the endosperm (Fig. 2). Such a structure has not been noticed before in the *Commelinaceæ*. While the ovule increases in size, there appear four infoldings of the wall, which develop into the pits found on the seed.

The haploid number of chromosomes in the pollen mother cells is ten in *Cyanotis axillaris* and twenty in *Aneilema spiratum*. These have been determined for the first time. Size differences exist among the gemini in both the plants (Fig. 1). In the early stages of its formation, mitotic divisions take place in the tapetal periplasmodium in the anther. Needle-shaped crystals are observed in the periplasmodium when the fresh anthers are teased out. The peculiar rod-like bodies figured by Maheshwari and Singh* in *Commelina*

* Maheshwari, P., and Bahadur Singh, "A Preliminary Note on the Morphology of the Aerial and Underground Flowers of *Commelina benghalensis*, Linn." *Curr. Sci.*, 1934, **4**, 158-160.

benghalensis are not found in the periplasmodium of the plants studied by the writer. The microspores contain only two nuclei at the shedding stage. The division of the generative nucleus, which usually becomes sickle-shaped, takes place in the pollen tube.



Double fertilisation has been observed in *Cyanotis cristata*. During syngamy the male nucleus shows spireme condition of its chromatin, while the egg nucleus remains in the resting stage.

The embryo of *Cyanotis cristata* is at first merely a spherical mass of cells, thus conforming to the Pistia-type. The sheath of the cotyledon is formed early as a circular outgrowth from the peripheral zone of the apical portion of the developing embryo; the lamina of the cotyledon subsequently arises as a lateral outgrowth on the sheath (Fig. 5). The stem apex then takes its origin in the central depression of the apical or terminal portion, which alone thus forms both the cotyledon and the stem apex (Fig. 6). The growth of the cotyledonar lamina gradually extends by its lateral margins, which merge with its sheath. In the mature embryo, the cotyledon forms a complete covering over the vegetative point. The radicle is differentiated from the central portion of the broad proximal end (Fig. 3). During germination the cotyledon remains in the seed as a spherical structure, and develops a long thread-like stalk, connecting the seedling with the seed (Fig. 4).

The development of the embryo of *Cyanotis cristata* briefly described here is in accordance with the view adopted by Worsdell† for the embryo situation in the *Commelinaceæ* and the *Dioscoreaceæ*. On the other hand, Solms-Laubach‡ stated that the cotyledon is lateral in origin in the above-mentioned families.

I am indebted to Dr. M. A. Sampathkumaran under whose direction this work has been done.

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Bangalore,
November 27, 1934.

Contribution to the Morphology of *Ottelia alismoides* (Pers.).

PLANTS of the family *Hydrocharitaceæ* have received considerable attention since the time of Fischer[1] (1880), who has worked out the development of embryo-sac in *Elodea canadensis*. Particularly interesting and exhaustive among them is the work on *Vallisneria spiralis*, which is the classic example to illustrate water pollination. Recently, Rangasami[3] has worked out the complete life-history of this plant. Palm[2]

† Worsdell, W. C., "The Morphology of the Monocotyledonous Embryo and that of the Grass in particular." *Ann. Bot.*, 1916, **30**, 509-524.

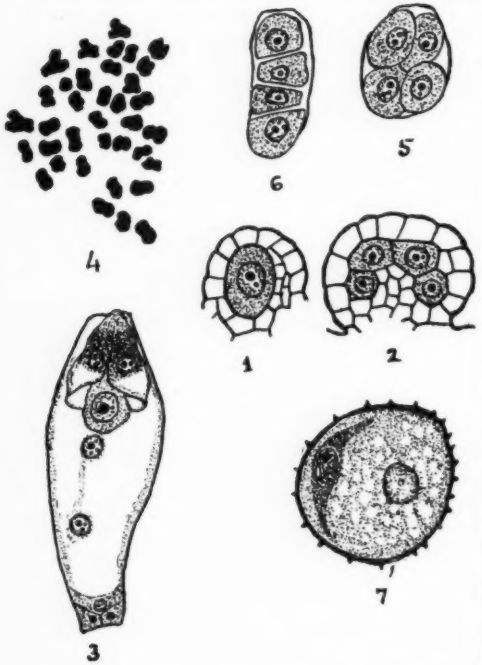
‡ Solms-Laubach, H. Grafzu, "Uber monocotyle Embryonen mit scheitelburtigen Vegetationspunkt." *Bot. Zeit.*, **36**, 1878. (Abstracted by Schnarf, K., *Embryologie der Angiospermen*, Berlin, 1929).

1-2 Extract from *Schurhoff's Die Zytologie der Bluten Pflanzen*. 1926.

3 Contribution to the Life-history of *Vallisneria spiralis*, *Journ. Ind. Bot. Soc.*, 1934.

has reported the development of embryo-sac in *Ottelia lancifolia* to be of the usual Helobiæ type. Some of the observations made below show interesting variations from the species studied by him.

Megasporogenesis:—Usually, there is a single hypodermal archesporial cell (Fig. 1); but occasionally it may be multi-cellular



(Fig. 2). In any case, only one develops and directly becomes the megaspore mother cell. After the usual heterotypic divisions, a linear tetrad is formed of which the chalazal megaspore develops to form a typical 8-nucleate embryo-sac (Fig. 3). The synergids are very conspicuous; each, being pyriform in shape, consists of a hyaline beak and a large vacuole at the base (Fig. 3). The egg is suspended between these two synergids. The antipodals are organised into cells (Fig. 3). The two polar nuclei are half-fused by the time the pollen tube enters.

Microsoporogenesis:—The earlier development of the anther is normal. The tapetum ultimately forms a periplasmodium with isolated cells. A similar case is reported by me in *Limnophyton obtusifolium* (Miq.)[4]. The endothecium is ill-developed. The chromosome number is 36 (haploid) (Fig. 4). The tetrads of microspores are usually isobilateral (Fig. 5), but frequently they are arranged in a linear series which is rather peculiar (Fig. 6). Another interesting feature is the structure of the pollen grain (Fig. 7). While all the members of the *Hydrocharitaceæ* so far investigated show three nuclei in the pollen grain at the time of shedding, in the case of *Ottelia alismoides* a tube nucleus and a generative cell are found.

Grateful acknowledgment is due to Dr. M. A. Sampathkumaran for helpful criticism and guidance.

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November, 1934.

[4] Life-history of *Limnophylon obtusifolium*, *Curr. Sci.*, 1933, **2**, 53.

Specificity of Parasiticism by *Eublemma amabilis*.

IMMS AND CHATTERJEE[1] were the first to realise that "no appreciable improvement is likely to result in lac cultivation until experiments have been conducted with reference to the elimination of insect enemies." There are at once two ways open in following such an enquiry, one of eradicating the enemies, the other of making the lac insect more resistant. The former appeals to an infectionist who would argue, just as a tiger is all-powerful in comparison with a buffalo so that the latter's health cannot be given the least thought in considering its having fallen a prey to a tiger; likewise no parasite would spare a host if it is unprotected and within easy reach. He would also grant as a corollary it is not only one species but several insects which can be attacked by the same parasite if the hosts are equally weak and helpless. The other line of research would be taken up by a predispositionist who would emphasise the somatic condition of the parasitised insect as compared with an immune host. To give a concrete example Sreenivasaya[2] showed that a deficiency of Calcium in the food of the lac insect resulted in an increased death rate from parasiticism. Apart from physiological factors of predisposition

[1] Imms and Chatterjee, "Structure and Biology of *T. lacca*," *Ind. For. Mem.*, 1915, **3**, Pt. 1.

[2] M. Sreenivasaya, "The Fundamentals of intensive Lac Production," *J. Sc. Assoc., Maharaja's Col., Vizianagaram*, 1924, **1**, 436.

there are more subtle constitutional ones pertaining to specificity of parasiticism.

As majority of entomologists belong to the infectionistic school of thought, Imms and Chatterjee have naturally considered the possibility of alternate hosts of lac parasites and stated, "to solve this problem adequately involves an investigation of all likely coccids occurring within the lac producing areas and breeding the parasites therefrom". Following their suggestion, I actually undertook as thorough a survey of the coccid fauna of Bangalore as I could possibly make which led to the discovery of new species of lac, pseudo-lac and other scale insects. Likewise, parasites were also reared from these coccids giving rise to several new species and some new genera of chalcids. After a thorough survey I[3] concluded, "There is no danger to the lac insect in its common enemies having alternate hosts . . . . for such an enquiry . . . . gave at every step a negative result . . . . and (led) to specificity of parasiticism." Glover[4] nevertheless says, "Several (lac parasites) are suspected of parasitising also insects other than lac . . . . the alternative host forms a convenient breeding ground for the parasites." As a concrete example he writes, "*Machærota* . . . . is an alternative host for *Brasema annulicaudis*. This latter enemy not only harms lac but is also a hyperparasite of the lac friends, *Apanteles tachardiæ* and *Bracon tachardiæ*." Before Cameron, Howard had already named the same insect *Anastatus tachardiæ* which Dr. Gahan kindly points out, should be corrected to *Eupelmus tachardiæ*. Now Imms and Chatterjee had suspected it as a beneficial insect while I definitely proved it to be a parasite of *E. amabilis* caterpillars. As circumstantial evidence I[5] had mentioned that Gernet, who studied dried specimens of stick lac in Russia before 1863, was the first not only to illustrate a caterpillar of *E. amabilis* but also to give two figures of *Eupelmus tachardiæ*, How.—the close association of the host and the parasite was thereby indirectly supported. Glover takes no notice whatever of previous references and to the contrary, makes the glaring statement of having found it inimical to lac itself.

As previously remarked, factors pertaining to predisposition are constitutional and physiological. That *E. amabilis* attacks only the commercial lac insects of the genus *Lakshadia*, and never the allied ones *Metatachardia* or the pseudo-lac insects of the germs *Tachardina*, would be considered an inherent factor. That some lac colonies may escape the attack of *E. amabilis*, in a locality where this moth does occur, would not be considered merely accidental but a consequence of a physiological factor making the particular colony immune. It would be imagined that an unhealthy lac colony emits odours attractive to the parasite while a healthy one would avoid sending such suicidal messages. This is not a lame hypothesis. It was found *Lakshadia mysorensis* growing on *Acacia farnesiana* and on *Pithecolobium dulce* in the same locality, would show a far greater degree of injury on the latter or the less suitable host plant. In fact by growing a less suitable host along with the favourite tree and both infected with lac, the former would trap or attack the greater portion of the moths. Before a second generation of the parasite emerges, the crop is harvested and destroyed to prevent the parasite from breeding. This may be called a catch crop for the destruction of the parasite. Sreenivasaya and I have successfully tried this experiment at Dorsanipalya where *A. farnesiana* was grown to entrap the larger number of parasites which would otherwise all attack the lac colonies on *Shorea talura*. The colonies on *A. farnesiana* were physiologically handicapped in their race for life in order to save the colonies on *S. talura* against the aggression of *E. amabilis*.

The following experiment was undertaken to show the constitutional basis of predisposition. In a plot where *A. farnesiana* plants were growing it was found that the most common scale insect, *Anemolus indicus*, had colonised itself. Six plants were selected and divided into three pairs. One pair had *A. indicus* and *Lakshadia mysorensis* each. The second two plants had *Tachardina ternata* (brood lac imported from Travancore) and *L. mysorensis*. The last set had *A. indicus* and *T. ternata*. The plants were growing so close to each other that several branches touched one another. Branches were cut at different intervals to examine the eggs of predacious moths; on this

[3] S. Mahdihassan, "Some insects associated with lac and a symbolic representation of their inter-relationship," *J. Sc. Assoc., Maharaja's Col., Vizianagaram*, 1925, **2**, 86.

[4] P. M. Glover, *A Practical Manual of Lac Cultivation*, Calcutta, 1931.

[5] S. Mahdihassan, same as No. 3 above, p. 76 and also reference No. 6, p. 395.

there has appeared a separate article.[6] On *L. mysorensis* eggs of *Eublemma amabilis* and of *E. scitula* were found. On *A. indicus* no *E. amabilis* had laid an egg and so was *T. ternata* free from it; *E. scitula*, however, had attacked both these insects which it also does in nature. It would be admitted that *T. ternata* has a very soft encrustation while the skin of *A. indicus* is softer than the encrustation of *T. ternata*. thus there was no question of the hosts being mechanically protected against the weapon of attack possessed by the caterpillar of *E. amabilis*. It was a case of the sheer instinct of the female moth refusing to lay eggs on hosts constitutionally unfit to feed its progeny. It may be said finally that *E. scitula*, so rare in the forest of *S. talura*, had increased its activity when the lac insect was growing on a less favourite host, *A. farnesiana*.

S. MAHDIHASSAN.

Hyderabad,
Deccan.
November 1934.

Fruit and Seed Development of *Tinospora cordifolia*, Miers.

EXEMBRYONATE SEEDS.

IN the August number of *Current Science* Joshi and Rao[1] published their interesting note on the Fruit and Seed development of *Tinospora cordifolia*, Miers, on which Sahni[2] has since commented. Among other things the authors report the absence of embryos in a large number of seeds examined by them, although they found the female gametophyte maturing to the normal embryosac stage, and also a copious development of the endosperm. The fruits were otherwise outwardly quite normal.

It is further reported that both pollination and fertilisation do not ensue, and the various parts of the embryosac finally degenerate, leaving only the two polar nuclei, which multiply and produce the endosperm in the absence of the "double fertilisation". The embryo, however, is not developed. Under these circumstances the authors are unable to account for the formation of "apparently normal seeds and fruits". As an alternative to the possible stimulus of foreign pollen, which was never seen, they suggest that the fruit and seed development may have been induced by the formation of the endosperm itself. This surmise is, however, not in accord with the facts already published on the subject. Moreover, they do not offer any explanation for the development of the endosperm itself in the absence of the triple fusion.

The facts communicated by the authors are by no means a rare and isolated phenomenon. In fact the case of *Tinospora cordifolia* is another illustration of what is known as *Parthenocarpy*, which has long been known, more specially in connection with the cultivated plants. It is characterised by the development of fruits without embryos. The earliest record indeed goes as far back as the year 1694 when Camarius, as cited by Schnarf,[3] commented upon the occurrence of seedless fruits. Since then it has been discovered to be of fairly general occurrence, being found, besides numerous other plants, in oranges, grapes, bananas, figs, apples, pears, etc. In consequence of its many-sided interest, a rich literature has now grown up. This has been dealt with and summarised in the pioneer works of Molisch,[4] Fitting,[5] Tischler,[6] Winkler,[7] Schnarf[3] and Engler,[8] to which reference may be made for fuller information. Here it is only possible to refer briefly to a few facts in so far as they have a direct bearing on the note under reference.

According to Tischler the following conditions may be distinguished:— (1) Cases where a normal embryosac is developed, and (2) Cases where a normal embryosac is not developed.

The cases coming under the first category to which *Tinospora* belongs, are further characterised by:—(*a*) The ovules can develop endosperm without fertilisation, (*b*) Only the sporophytic parts of the ovule can

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[6] S. Mahdihassan, "Schmetterlingsraupen als Feinde der lackschildläuse," *Natur und Museum*, 1929, **59**, 394.

[1] *Curr. Sci.*, 1934, **3**, 62.

[2] *Curr. Sci.*, 1934, **3**, 109.

[3] *Embryologie der Angiospermen*, Berlin, 1929, 547.

[4] *Pflanzenphysiologie als Theorie der Gärteneri*, Jena, 1930, 296.

[5a] *Biol. Centralblatt*, 1909, **29**. Cited by Engler in [8].

[5b] *Zeitschr. f. Botanik*, 1909, **1**, 1; 1910, **2**, 4. Cited by Engler in [8].

[6] *Jahrb. wiss. Bot.*, 1913, **52**, 1.

[7a] *Pfropfbastarde*, 1912, Jena.

[7b] *Parthenogenesis im Pflanzen u. Tier-reiche*, 1920, Jena.

[8] *Die nat. Pflanzenfamilien*, 1926, **14A**, 121, Leipzig.

undergo further development, and (*c*) The entire ovule degenerates, sometimes only after a few otherwise commonly occurring events in normal fruit formation have taken place.

As is clear, the facts described by Messrs. Joshi and Rao accord with the condition described under (*a*). Of this Tischler has investigated more closely the case of *Ficus carica* in particular. From this the following results are culled:—(1) There is complete absence of fertilisation and generally of every other external stimulus. (2) In many ovules endosperm developes into a typical nutritive tissue; in others it dies early. (3) During wall-formation an unequal number of nuclei are often enclosed in a cell. (4) Sometimes the endosperm formation does not proceed equally throughout the embryo-sac, a number of tissue-complexes being developed instead. (5) In ripe endosperm autodigestion takes place resulting in ruminate endosperm.

The results of Tischler summarised above not only agree entirely with the observations of the authors, but they are also more embracing. The authors might well revise their investigation in the light of these facts.

Other plants in which similar conditions exist are *Cælobogyne ilicifolia*, *Dasylirion acrotrichum*, *Theobroma cacao*, *Ananassa sativa*, etc.

As for the development of the endosperm before fertilisation, to which the authors have referred, in the case of normal plants, Schnarf[3] says "Researches that in amphimictic plants the endosperm developes normally without or before fertilisation, must in general be regarded with mistrust". According to him the stimulus for the normal development of the endosperm is supplied by the second sperm nucleus. A misleading situation is often created in cases where, in spite of a normal fertilisation, the egg remains quiescent whereas copious endosperm is meanwhile developed, conveying an impression that the latter has been developed in the absence of fertilisation. A number of examples of this kind are cited by Schnarf.

The development of the endosperm, however, in parthenogenetic and parthenocarpic plants offers both unusual and interesting features. Here it is certainly developed in the absence of fertilisation. And it is now definitely demonstrated by the researches of Haberlandt,[9] Eichler[10] and others, that it is induced by necrohormones or wound-hormones in consequence of the wounding of the ovary artificially or by the action of parasitic fungi and insect-larvæ, as well as by castration. Haberlandt and his students have also demonstrated that the necessary stimulus may be supplied by the decaying cells in the neighbourhood, and even by the disorganising egg. The stimulus supplied by the entrance of the pollen tube has also been found to initiate the development of the endosperm, as also the influence of foreign pollen to which reference has been made. Even the extract of the living or dead pollen has been found to induce changes in the gynæcium.[5] Furthermore, increase of temperature, as well as osmotically active solutions of grape sugar, urea, $MgCl_2$, KNO_3, etc., can also cause endosperm development in the absence of fertilisation (Schnarf,[3] p. 322).

From this it is clear that the endosperm development can be brought about by a variety of causes on failure of fertilisation, and it will be difficult in any particular case to ascribe endosperm formation to any particular cause, without a series of carefully conducted experiments. In the absence of any other demonstrable cause, endosperm development in *Tinospora* may be induced by the disorganising contents of the embryo-sac itself, which the authors report.

The absence of pollination is hard to understand. Menispermaceæ are according to Diels[11] entomophilous, and in the case of *Tinospora* I myself have observed the visits of insects, including bees. A dense foliage and a distance of a few hundred feet would hardly seem to explain absence of pollination in entomophilous flowers. But this is a point on which speculation is useless.

Regarding the absence of embryos from the fossil gymnospermous seeds, Dr. Sahni

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[9a] *Sitzb. preuss. Ak.*, 1921, **40**, 695; **51**, 861. Cited by Schnarf in [3].

[9b] *Sitzb. Ak. Berlin*, 1922, **25**, 336. Cited by Schnarf in [3].

[9c] *Biol. Zentralbl.*, 1922, **42**, 145. Cited by Schnarf in [3].

[9d] *Beitr. z. allg. Bot. Haberlandt*, 1923, **2**, 1. Cited by Schnarf in [3].

[9e] *Ueber. Zellteilungshormone*, June, 1930, Scientia.

[10] *Öst. bot. Zischr.*, 1906, **56**, 337. Cited by Schnarf in [3].

[11] *Das Pflanzenreich*, 1910, Hft. **46**, 4, 94, Leipzig.

himself has cited the case of *Ginkgo*, on the analogy of which this fact is attempted to be explained. I do not know if an answer has ever been sought in the direction of the explanations which apply in the case of the parthenocarpic plants. One should like to know if even a remote contingency of this kind can exist.

Another question that has been raised is whether *Tinospora* seed germinates at all; if not, how does the seedling arise? There do not seem to be any observations bearing on this subject. In general, the floras do not make any mention of the presence of an embryo in *Tinospora* seeds. Even Diels' monograph referred to above makes no mention of it. All that is usually referred to with reference to the contents of the seed is "glutinous pulp". From this one may presume that an embryo is perhaps never formed. The question of germination in the absence of the embryo does not therefore arise. As for the endosperm itself functioning as the embryo, there is no recorded instance, though in cases of apogamy embryos are produced by the budding of the endosperm. In any case, should an embryo be formed its presence would be detected. As is well known, this plant is multiplied vegetatively by cuttings, and this, so far as known, is the only method of propagation. It may turn out, as is frequently the case with such plants, that *Tinospora* has completely lost the power of reproduction by the functioning of its gametes, and even by the production of the embryo by alternative methods. Dicecious plants are specially liable to failure of fertilisation owing to the distribution of their sexes on separate individuals growing often wide apart, and in them therefore, the phenomenon of parthenogenesis is comparatively more frequently exhibited. This may also apply to *Tinospora*. In this connection the occurrence of parthenogenesis in another member of the family as reported by Ernst,[12] may not be without significance.

It would be extremely interesting and highly instructive to investigate the biology and life-history of this plant more thoroughly.

N. K. TIWARY.

Benares Hindu University,
October 1934.

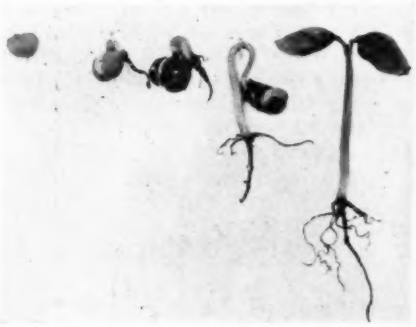
[12] *Nature*, 1886, **34**. Cited by Diels in [11].

SEEDS AND SEEDLINGS OF *Tinospora cordifolia*, MIERS.

JOSHI AND RAO[1], in their account on the fruit formation in *Tinospora cordifolia*, Miers, have observed that the fruits develop possibly by the influence of foreign pollen and though they look apparently normal with copious endosperm, yet the seeds, it is reported, are destitute of embryos.

Sahni,[2] while discussing the possible influence of foreign pollen on fruit formation, rightly questions how the plants originate when the seeds are exembryonate.

In this note, without entering into the morphological details it is recorded that the



seeds of *Tinospora cordifolia*, Miers, though developed perhaps by the influence of foreign pollen, possess embryos which are perfectly viable. The embryo can be seen, even without the help of a hand lens, after dissecting out the ruminate endosperm with which it is surrounded. Seeds that were sown have germinated successfully. The seedlings shown in the photograph were collected soon after the rains during the month of September, from the neighbourhood of the parent plant.

The plant has been kindly identified by the Government Systematic Botanist, Coimbatore, as *Tinospora cordifolia*, Miers.

K. N. SESHAGIRIAH.

Department of Botany,
Central College,
December 5, 1934.

[1] *Curr., Sci.*, 1934, **3**, 62 and 63.
[2] *Ibid.*, 1934, **3**, 109 and 110.

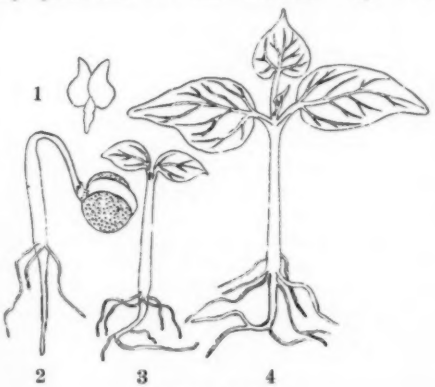
THE SEEDS OF *Tinospora cordifolia*, MIERS.

THE recent note by Joshi and Rao on "Fruit and Seed Development in *Tinospora cordifolia*, Miers, without Fertilisation and Embryo Formation inside"[1] was read by me with a certain amount of surprise. In a previous issue of this journal[2] Prof. B. Sahni has made some further remarks on exembryonate seeds and asks two pointed questions: "How does the *Tinospora* seed germinate if at all?" and (2) "Whence does the seedling take its birth?".

Joshi and Rao have omitted these points altogether and thus the latter part of their paper loses a great deal of its value and interest.

About two years ago I started some work on the morphology of this plant, the material of which had very kindly been fixed and imbedded by Mr. Babulal Gupta of this Department. Due to unavoidable circumstances I had to give up my work for some time and it is only recently that I have taken it up again.

I can definitely say that *the seeds of Tinospora cordifolia do possess an embryo and they germinate in the normal way.* The



Figs. 1-4.

1. Embryo dissected out of a seed soaked in water. × Natural Size.
2. Young seedling. × Natural Size.
3. Same, slightly older. × ½.
4. Young plant showing two cotyledons and 2 new leaves. × ½.

embryo is very hard pressed to the endosperm and is difficult to recognise as the cotyledons are very thin and their colour is the same as that of the endosperm. Fig. 1 shows an embryo dissected out of a seed.

[1] *Curr. Sci.*, 1934, **3**, 62.
[2] *Ibid.*, 1934, **3**, 109.

Immediately on receipt of the paper by Joshi and Rao, I sowed 75 seeds of which 50 germinated within a week and the seedlings were entirely normal in appearance (Figs. 2, 3 and 4). Of those that did not germinate, some were dug out and on dissection an embryo was found in every one of them. This indicates that germination was merely delayed or perhaps stopped in these cases due to entirely different causes. Apart from this, I have also been able to find seedlings growing in nature.

It is true that male plants are very rare in this species and the chances of effective pollination are meagre. This merely suggests that the development of the embryo is parthenogenetic—a fact recorded for several Angiosperms and for *Disciphania Ernstii*[3] (Ernst, 1886), a member of the family Menispermaceæ itself.

It is therefore to be desired that Joshi and Rao will re-examine their preparations and remove the source of error, wherever it lies. I reserve further remarks for a future occasion.

My preparations have been examined by Dr. P. Maheshwari and I have his support for my conclusions.

BAHADUR SINGH.

Agra College, Agra,
October 3, 1934.

WITH regard to the earlier note of Dr. Sahni[1] and the above note of Mr. Bahadur Singh, I would point out that the observations of Rao and myself do not exclude the possibility of occurrence of embryonate seeds in *Tinospora cordifolia*. As was pointed out by us, the case appears to be comparable in all essentials with what is seen in *Cycas*. We only showed that it is possible in *Tinospora* for the seed and the fruit to develop without the formation of embryo inside. The conclusion was based mostly on the study of microtome sections, and I hope after further investigation Mr. Singh would be able to agree with it. The species can be propagated either from embryonate seeds or as is the usual practice in gardens, from cuttings.

A. C. JOSHI.

Department of Botany,
Benares Hindu University,
November 1934.

[3] Ernst (1886) Quoted in Schnarf, K., *Vergleichende Embryologie der Angiospermen*, 1931, 73.
[1] Sahni, *Curr. Sci.*, 1934, **3**, 109.

Soil Temperatures.

BY L. A. RAMDAS and R. K. DRAVID,
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THE temperatures attained by the soil at different depths below its surface are of importance in agriculture and depend upon a number of factors, the more important of which are enumerated below:—

1. Duration and intensity of solar radiation.

2. Colour and cover (*e.g.*, vegetation) of the soil which determines the fraction of the solar radiation which is absorbed by the soil surface.

3. The thermal conductivity of the soil which again varies with:

(*a*) the chemical composition,
(*b*) the water content, and
(*c*) the pore space or apparent density.

4. Air movement or convection above the soil surface.

5. Radiation exchange, especially in the long wave-length or infra-red region of the spectrum between the atmosphere and the soil surface.

An account of the heat balance at the ground surface would involve the careful measurement of the numerous factors mentioned above at a number of representative places. For a preliminary survey of this problem, however, it is possible to eliminate the variations of some of the factors and study the influence of each separately.

First of all, the variation due to climatic differences from place to place may be eliminated by bringing sufficiently large soil samples to one place of observation. N. K. Johnson and E. L. Davies[1] have measured temperatures at a depth of one centimetre in blocks of Tar, Macadam, Bare-Earth, Sand, Rubble, and Bare Clay 1 metre square and 15 cm. deep. In view of the fact that the samples were 15 cm. deep, their results may be expected to represent the joint effects of the colour and composition of the materials used.

A simpler way of arranging such experiments is outlined below:—

(1) The physical and chemical properties of the soil may be kept identical by working with blocks of the local soil in the natural condition and varying only the "cover" or surface by sprinkling a very thin layer (about 1 or 2 mm. thick) of each foreign soil over its assigned plot. Then only the "colour" or "albedo" factor varies from plot to plot.

(2) The effect of varying the physical and chemical composition of the soil may be studied by working with blocks of different soils of sufficient depth and covering the surfaces of all the blocks with the same soil, preferably the local soil.

At the Agricultural Meteorological Observatory, Poona, the first part of the above programme, *viz.*, a preliminary study of the effects of surface covers on the local soil, was commenced during the winter of 1933-34. The effects of covering the local black cotton soil with:

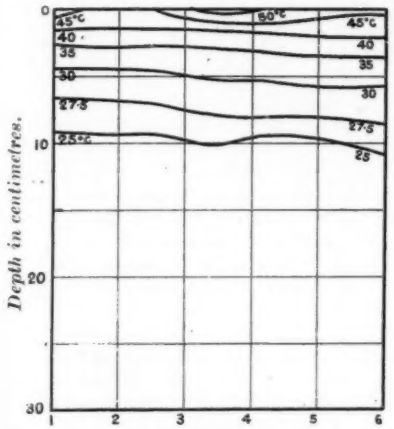
(i) a very thin layer of chalk powder,
(ii) a very thin layer of charcoal powder, and
(iii) wetting just the surface of the soil with known quantities of water,

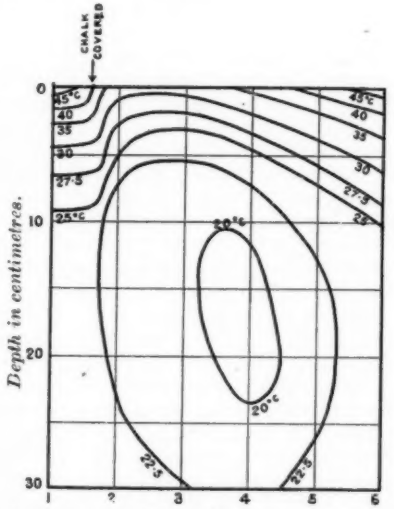
was studied by taking simultaneous two-hourly readings of the soil temperature in two plots one of which was kept as the control and the other was given the treatments referred to above successively. Before commencing each experiment the two plots were kept similar for a sufficient period so as to equalise the initial conditions.

The results obtained in the case of chalk powder and watering to an extent equal to $\frac{1}{2}$" rain are shown in Figs. 1 and 2.

Figs. 1 (*a*) and (*b*) are isopleths of the weekly mean temperatures at 1400 hours in the afternoon in the control and chalk covered plots respectively. The abscissæ refer to the successive weeks and the ordinates refer to the depths below surface. The plots were similar during the 1st week. The layer of chalk powder was given at the beginning of the 2nd week and kept on during the 2nd, 3rd and 4th weeks. At the end of the 4th week the chalk coating was removed. The very conspicuous lowering of the soil temperatures during the 2nd, 3rd and 4th weeks in the experimental plot is shown by the rapid approach of the isotherms towards the surface. It is also interesting to note that it took nearly two weeks after removal of the chalk for the temperatures to equalise in the two plots.

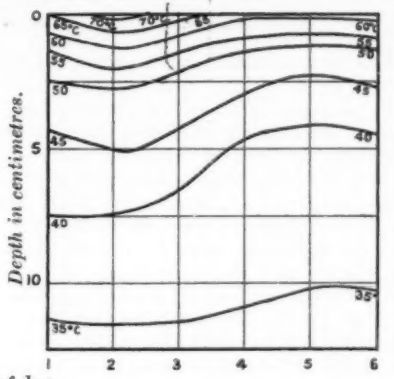
[1] *Quarterly Journal of the Roy. Met. Soc.*, 1927, **53**, 45.

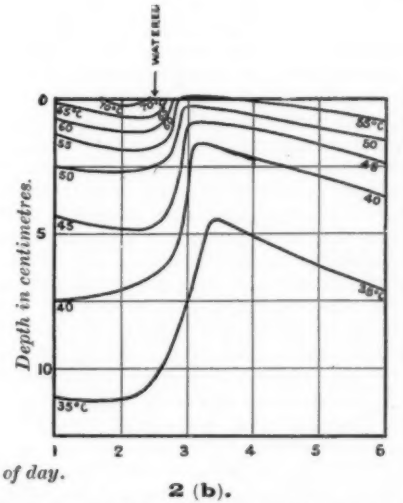




Figs. 1 (a) & 1 (b).—Effect of a thin layer of chalk powder on weekly mean soil temperatures at 1400 hrs. I.S.T. (25-12-33 to 1-2-34). (*a*) Control; (*b*) Chalk put on at the beginning of the 2nd week.

Figs. 2 (*a*) and (*b*) are the isopleths of daily temperatures at 1400 hours in the control and the surface-wetted plots respectively. The wetting was done at 6 a.m. on the 2nd day. The sudden cooling communicated to the various soil layers is clearly brought out by the rapid approach of the isotherms towards the surface on the 2nd day. The recovery from the effects of wetting was gradual and the temperatures had not yet quite equalised even on the 6th day.





Figs. 2 (a) & 2 (b).—Effect of watering the surface on daily soil temperatures at 1400 hrs. I.S.T. (1-5-34 to 6-5-34). (*a*) Control; (*b*) Surface moistened on 3-5-34.

The effect of covering the soil with charcoal powder was less conspicuous because the local soil is already black or nearly black in colour.

This year soil samples of different varieties of colour and texture have been secured from different parts of India and experiments with five plots are being commenced. The effect of different intensities of wetting as well as of a vegetative cover are also included in the programme.

Entomological Investigations on the Spike-Disease of Sandal.

Indian Forest Records. Entomology Series. Published by the Government of India, 1932-33.

THIS is a valuable series of entomological papers issued in connection with the investigation of the entomological aspects of the spike-disease of the Sandal tree (*Santalum album*) in South India carried out by the Forest Research Institute, Dehra Dun, on behalf of the Forest Departments of Madras and Coorg in South India. The results of this investigation on sandal entomology which occupied a period of over three years from 1930 have been published in parts and so far twenty-four parts have appeared in the *Indian Forest Records* Series. Of these twenty-four papers, No. 1, part of No. 2 and No. 20 give us an idea of the history and genesis of the main problem of sandal spike-disease, the programme of investigation, the progress of the work and the final results of the investigation of the main problem of the relation of insects to the sandal tree and the part they might play as vectors of the spike-disease. The other numbers—twenty-one parts in all—deal chiefly with the systematics and bionomics of the different groups of insects collected from sandal and are papers prepared by specialists to whom the different groups of insects were submitted.

In the first number of the series, Dover gives an account of the whole problem of the sandal spike including the history of the disease, early spike investigations and their results and discusses the different possible methods of transmission of the disease and lays stress on the likely transmission of the spike-disease by insects, especially by sucking forms and the economic importance, therefore, of intensive studies on the insect fauna of the sandal areas of Salem and Coorg. In the first part of the second paper Dr. Beeson gives a short account of the genesis of this insect survey idea, describes the organisation for research on the entomological aspects of the disease and adds some remarks on the transmission experiments started in connection with it in Salem and Bangalore. In Dr. Beeson's words "The faunistic survey had as its primary objective a determination of the constitution of the sandal insect association and the regional distribution of its component species."

The other papers include studies on special groups by well-known specialists. The groups studied so far include (*a*) *Beetles* of the families *Cicindelidæ* (by Horn and Chatterjee), *Coccinellidæ* (Korschefsky), *Bostrychidæ*, *Platypodidæ* and *Scolytidæ* (Beeson), *Anthicidæ* (Heberdey), *Lycidæ* and *Brenthidæ* (Kleine), *Anthribidæ* (Jordon), *Carabidæ* (Andrewes), *Melasidæ* and *Elateridæ* (Ftentiaux), *Crambycidæ* (Fisher); (*b*) *Neuroptera* (Banks); (*c*) *Thysanoptera* (Ramakrishna Ayyar); (*d*) *Formicidæ* (Mukerji); (*e*) *Rhynchota* families—*Jassidæ* (Pruthi), *Cercopidæ* (Lallemand), *Membracidæ* (Funkhouser) and *Pentatomidæ* and *Fulgoridæ* (Chatterjee). An examination of the forms noted in these systematic papers shows a very interesting and unusual record of about 500 species of insects found on this single tree *Sandal*. Of this number, 79 forms appear to be new to science including a few new genera. Greater attention, however, appears to have been paid to the groups of sucking insects especially the homopterous families *Jassidæ* and *Fulgoridæ*, and in the series we find special monographs on the life-history and morphology of three insects—the Jassid *Petalocephala nigrilinea*, W. and the two Fulgorids *Sarima nigroclypeata*, M. and *Eurybrachys tomentosa*, F.—all by Mr. N. C. Chatterjee. The reason for the special attention paid to these three insects appears to be that these were found fairly common and injurious to sandal and were considered as probable vectors of the spike-disease. These three papers recording intensive studies on the different aspects of individual insects are extremely interesting and useful and have added to our knowledge of these bugs in many ways, as for example, in the case of two of these insects, *viz.*, *Petalocephala* and *Eurybrachys* it has been found by breeding that three described species of each of them are after all the two sexes of one of the same species! In addition, these intensive studies on particular species as types give hemipterists a general view of the life-history and bionomics of the family as a whole—a feature which is of great importance to future workers in this line. As a result of these studies on Homoptera the jassid *Moonia albimaculata* was pitched upon as the most probable vector of the spike-disease and in paper No. 20 of the series, Dover gives an account of the different series of trials such as mass infection

experiments, group experiments and specific vector experiments explaining the methods adopted and the insects utilised; he also adduces different kinds of evidences to incriminate the insect *Moonia albimaculata* as the possible vector of the disease and finally summarises the results of the experiments conducted so far by stating (1) that field investigations and biological analyses strongly support the theory that spike-disease is transmitted by insects, (2) experiments with several species of bugs appear to confirm the theory advanced that *Moonia albimaculata* is a very probable vector of spike-disease, and (3) lantana aphid (*Macrosiphum*) is also a probable vector of the disease. On the whole, it would appear from Dr. Beeson's post-script at the end of this paper that the Sandal Spike Investigation Board "is not wholly agreed that the available evidence demonstrates conclusively that spike has been experimentally transmitted by insects or that *Moonia albimaculata* is a proved vector." It would appear, on the whole, however, that the problem of insect agency in the dispersal of sandal spike is still a moot question demanding further investigations for confirmation. This is evident from further opinions of a controversial nature expressed on the subject in the columns of *Nature* (1933, p. 592), *The Indian Forester*, (1934 pp. 492 and 505) and later in this journal itself in July last.

It was unfortunate that, in the meantime, the special grant subsidising research on spike-disease expired in September 1933 and the investigations had to be abruptly closed down. In our opinion, though the transmission experiments have carried us considerably forward towards the elucidation of the ways of this mysterious disease there is still room for a good deal of further work in this direction. Speaking of the entomological aspect of the investigations we venture to think that separate observations on the insect fauna of healthy and spiked trees and data collected for each of these sets might have also helped towards the fixing of the transmitting agency to insects if the disease is really insect-borne and in the case of experiments with *Moonia* we venture to think that experiments might have been tried to feed the nymphs of the bug on the infectious material, and allow it to become an adult before it is allowed to feed on a healthy shoot instead of using the adult insect. It is perhaps likely that, as in the case of the insect *Thrips tabaci*—a well-known insect vector, for proper infection of healthy tissue—it is necessary that the young one of the insect should be fed on infectious material and allowed to grow into an adult before it is able to inoculate the toxin. In the event of this investigation being taken up again, it is hoped that this and other lines of research may be tried. It would also be advantageous if an experienced Mycologist or at least one who thoroughly knows the technique of virus studies is also associated in such experiments.

In conclusion, we might add that, whatever might have been the results of the investigations on the main problem, from an entomologist's point of view the results of these faunistic studies present a unique and very valuable contribution both from the academic and economic points of view. For, this series of insect studies, the results of the very first attempt at an exhaustive and systematic study of the insect fauna of a single forest tree in the whole of India, and as such, the insect survey papers have substantially contributed to the subject of entomology as a whole. Entomological workers in general and particularly those in South India are especially indebted to Dr. Beeson who has been mainly responsible for the initiation of these entomological investigations and his assistants Messrs. Dover and Chatterjee for gathering the bulk of the material studied and for arranging to get done this exhaustive survey of the insect fauna of sandal, thus adding substantially to our knowledge not only of the insects associated with sandal but of the insect fauna of the whole of South India. We have also to congratulate them in securing the services of well-known specialists in the different groups who also deserve our thanks.

T. V. RAMAKRISHNA AYYAR.

Research Notes.

Almost Periodic Functions in a Group I.

THE theory of almost periodic functions built up by Bohr, Wiener, Besicovich and others has been extended in a remarkable manner by Neumann (*Trans. Am. Math. Soc.* **36,** No. 3). The theory of representations of continuous groups developed chiefly by Weyl (for an account of the theory see Weyl 'Group Theory and Quantum Mechanics') was shewn to include the theory of periodic functions as a special case. The determination of a canonical system of representations by means of which every representation of the group can be expressed corresponds with the problem of determination of a set of orthogonal functions by means of which every orthogonal function can be expressed. The notion of almost periodicity which was defined by Bohr for the case of functions $f(x)$ which are defined in $-\infty < x < \infty$ and which are continuous has now been extended by Neumann to the case of functions defined in any group G of an extremely general type. The definition he gives is this. Let $f(x)$ be a function defined in G (x denotes an element of the group) Next let M be the aggregate of all functions $f_a(x) = f(xa)$, where a denotes the various elements of the group. Now given any sequence of functions $f_1, f_2, \ldots, f_n, \ldots$ of M if we can find a subsequence $f_{\lambda_1}, f_{\lambda_2}, \ldots f_{\lambda_r}, \ldots\ldots$ such that the least upper bound of $|f_{\lambda\nu} - f_{\lambda\mu}| \to 0$ as ν and μ tend to ∞ then the function is said to be right almost periodic. In a similar manner the left almost periodicity is given.

The chief difficulty that was encountered was to find the analogue of the Bohr-mean *i.e.*, $\underset{T\to\infty}{\text{Lt.}} \frac{1}{2T}\int_{-T}^{T} f(x)\,dx$ as the groups considered are not assumed to be topological. Neumann overcomes this difficulty by defining a new mean in Part I. Neumann uses his results to deduce fundamental theorems concerning the representation of groups, which were given in case of various special groups by Weyl and Haar. It is also shewn that this theory of almost periodic functions is the widest range over which this theory of representations holds without any loss of generality. Part IV deals with the relations of this theory when the group has a topological structure and with the determination of all almost periodic functions belonging to the group. In Part V it is proved that the maximal amount exists in abelian groups (subject to certain topological restrictions). We await with great interest his further memoirs on the subject.

K. V. I.

Asymptotic Partition Formulae III.

PARTITION into k^{th} powers by Maitland Right. *Acta Mathematica*, **63,** pp. 113-91. Hardy and Ramanujan have determined the order of $p(n)$, *i.e.*, the number of partitions of n by means of the celebrated method of approximating the contour integral for $p(n)$. The author here proposes to determine the orders of $p_k(n)$, *i.e.*, the number of partitions of n into k^{th} powers. Hardy and Ramanujan had to deal with the singularities of the elliptic modular function and the known transformation theory of the function was of great help in finding out the nature of the function near a boundary point. In the case considered by the author the generating function did not possess any general transformation theory and therefore a good deal of his paper is devoted to the development of a transformation theory of the corresponding generating function. He obtains a formula for $p_k(n)$ which generalises the Hardy-Ramanujan conjecture, *viz.*, $p_k(n) = B_0 n^{b-3/2} e^{\Delta n^b}$ and also gives us the order of the error.

K. V. I.

Equilateral and Equiangular Hexagons in Space (The Carbon Six Ring).

K. R. GUNJIKAR published about a year ago in the *Journal of the University of Bombay* an investigation of the construction of equilateral and equiangular polygons in space. He only considered those cases for which $n \leqslant 6$ where n is the number of the sides of the polygon. It is only when $n=6$ there is any mathematical interest in the problem However the case $n=6$ is of special interest to the organic chemist. The investigation of the same problem has been recently published by P. C. Henriquez in the *Proceedings of Koninklijke Akademie van Wetenschappen te Amsterdam* on the very same lines of Gunjikar without noticing

his work. We will, however, give here the solution of the problem as given by Gunjikar. Let ABCDEF be the polygon, θ denote the complement of the angle between two adjacent sides and let α, β, γ be the angles made by the planes ABC, CDF and EFA with the plane ACE. (i) If $\alpha=\beta=\gamma$, α is imaginary for $\theta<60°$, there is one hexagon for each θ if θ lies between 60° and 120° and two such hexagons for each θ if $\theta \geqslant 120°$. (ii) If α, β, γ are not all equal, then α and β can be determined satisfying certain conditions, if γ is known. This is really a very interesting result. For real values of $\alpha, \beta, \gamma, \theta$ should be $\geqslant 60°$. If θ lies between 60° and 120°, γ can vary between $\pm \cos^{-1}\left[\frac{4\cos\theta-1}{\sqrt{3}} \cot\frac{\theta}{2}\right]$ and if θ is greater than 120°, γ can vary between $\pm \cos^{-1}\left(\sqrt{3}\cot\frac{\theta}{2}\right)$. Henriquez has given in his paper the above results of Gunjikar. The solutions (1) correspond to the 'non-deformable' ring and the solutions (2) correspond to the deformable ring. Henriquez has also given in his paper a discussion of the double six ring (two six rings with one side common) which is new.

N. S. N.

The Structure of Crystals.

THE recent issue of *Zeitschrift für Kristallographie* is devoted to papers on crystal structure. The subject has become, of late, a controversial one. The controversy lies in the understanding of the nature of real crystals occurring in nature. For example, if a real crystal possesses a perfect lattice so that the crystal planes responsible for the X-ray reflection are all parallel, then the reflection of a parallel incident beam of X-rays should occur only within a few seconds of the arc in the neighbourhood of the Bragg angle. Actually it is not so. To explain this discrepancy, Darwin introduced the idea of a mosaic structure with the assumption that the crystal planes which should be strictly parallel in an ideal crystal are not so in the case of a real crystal.

Later on, other mosaic theories were formulated by Smekal and Zwicky. According to Smekal's theory, a real crystal contains many pores and cracks running throughout the crystal in a manner such that the total volume of the pores and cracks is by far negligible compared to the volume of the crystal. According to Zwicky's first theory cracks will develop in a growing real crystal due to the contraction of the surfaces which are shown to bear great stresses. According to his second theory, a real crystal is a space lattice with a secondary structure throughout the volume. According to Zwicky, the crystal with the secondary structure is more stable than the perfect crystal. The *Zeitschrift* contains two of its papers by Buerger. Buerger has levelled a caustic criticism over Zwicky's theory of the secondary structure citing many experimental evidences. Apart from his criticism, he has presented in his other paper an account of his theory of the lineage structure of crystals. According to his theory, a real crystal is a continuous one but branched. Each branch is called a lineage and each lineage is an almost straight line lattice. He shows that his theory is supported by many experimental evidences including the X-ray results. The *Zeitschrift* contains also a paper by Buckley who has criticised the existing mosaic theories. In his paper he has given a brief account of each theory and has pointed out that they need correct interpretations of experimental evidences supported by right theories. He has criticised the Darwin mosaic on the ground that it assumes inhomogeneity in a real crystal just to interpret the X-ray results while there are many more experimental facts to support the idea that a real crystal is a homogeneous one. The *Zeitschrift* contains also many more important papers by Smekal, Goetz, Taylor, James and others.

N. S. N.

Artificial Radioactivity produced by Neutron Bombardment.

IN the *Proceedings of the Royal Society* (1934, **146**, 483), E. Fermi and his collaborators have given a collected account of the results obtained by them by bombarding various elements with neutrons. In this process new isotopes of elements have been obtained which do not correspond to known stable isotopes, but are unstable and disintegrate with definite half-value periods. This induced radioactivity was first discovered by Curie and Joliot and has been described in a previous note in this *Journal*. While Curie and Joliot used α-particles as missiles and were thus limited to a study of the light elements only, Fermi and his

co-workers have used neutrons and have been able to observe induced radioactivity in almost all the elements with only a few exceptions. The paper contains a table at the end which gives all their results at a glance. The probable active isotope produced by the neutron bombardment, its half-value period, the intensity of the activity, mean energy of the β-rays emitted and the presence or absence of ν-rays, are all listed. The presence of an active product having a half-value period of 13 minutes in the case of Uranium had been previously interpreted on the assumption that a new element of larger atomic number than 92 was responsible for this particular activity. Another component of half-value period 90 min. is also found to give reactions similar to those of the 13 min. product and both are concluded to be elements of higher atomic number than 92, probably being isotopes of one such element. The other results obtained are (1) that a large percentage of chemical elements can be activated by neutron bombardment; (2) that most of the neutrons that meet the nucleus produce an active atom; (3) that the active product is sometimes an isotope of the bombarded atom, but in other cases its atomic number is less by one or two units (the former alternative was observed with five heavy elements, while the light elements conform to the latter alternative); and (4) that only electrons have been found to be emitted under the radioactivity but no positrons have been detected. These interesting results will no doubt prove valuable for understanding the constitution of atomic nuclei.

The Liquefaction of Helium by an Adiabatic Method.

EXPERIMENTS with liquid helium have led to discoveries of great importance such as supra-conductivity, but so far only four or five laboratories are equipped with the costly apparatus necessary for liquefying helium. Even these use a method that has a very low efficiency, *viz.*, the method which utilises the Joule-Thomson effect. It is well known that an adiabatic expansion method would be very much more efficient, but expansion engines working at such low temperatures have not been so far designed. The piston has to be air-tight and yet move without friction—a process which is only possible when a suitable lubricant can be found. In the case of air Claude made use of the liquid air itself as the lubricant, but even such an artifice is impossible in the case of liquid helium because it would have very low lubricating properties. But Prof. P. Kapitza has now devised an expansion engine which overcomes these difficulties and can produce liquid helium at 2 litres per hour using $1\frac{1}{2}$ litres of liquid nitrogen per litre of liquid helium for preliminary cooling. The new design is fully described in *Proc. Roy. Soc.* (1924, **147,** 189). Compressed helium enters through the inlet tube into a heat exchanger A and is then cooled to 65° K. by passing round a ring-shaped container having liquid nitrogen. It then goes through another heat exchanger B to the expansion engine and thence to a third heat exchanger C and back through B to the compressor. After a few circuits the cooling is such that part of the helium leaves the expansion engine in the liquid state, but the liquid helium is not separated out in this way. Instead, part of the high pressure helium, after passing through B, goes through C where it is cooled by the upcoming helium from the expansion engine, and then passing through a fourth heat exchanger D, it passes through an orifice into the liquefaction vessel where part of it liquefies on account of the Joule-Thomson cooling. The unliquefied gas goes back through D and C and goes back to the compressor. A throttle valve is used between D and the liquefaction vessel from which the liquid helium can be drawn off. Details of the design of the expansion engine and the heat exchangers are given in the paper.

The Statement of the Third Law of Thermodynamics.

ATTEMPTS have been made to make a simple and rigorous statement of the third law of thermodynamics ever since its formulation. One of such statements associates zero entropy with the lowest energy state (lowest quantum state). The criterion is often found to be either unnecessary or insufficient. A crystal of diamond is of zero entropy at the absolute zero of temperature, but is not in the lowest energy state. Crystalline solutions, on the other hand, are presumably in their lowest vibrational levels though the entropy cannot be taken as zero. Another statement of the third law ascribes zero entropy to a perfectly ordered

condition. Perfect order is undoubtedly a sufficient criterion though not a necessary one, as for instance, in the case of mosaic crystals, degenerate gases or electrons in metals obeying Fermi statistics. The principle of the unattainability of the absolute zero suffers from similar defects. Thus a concise statement of the third law has often proved a bit elusive.

The discussions of Eastman and Milner (*J. Chem. Phys.*, 1933, **1**, 441) and of Rodebush (*J. Chem. Phys.*, 1934, **2**, 668) make it clear that a system which is an exception to the third law (*e.g.*, glasses, solid solutions) differs significantly from other phases at the absolute zero only in the fact that the exemplars of the system differ among themselves and comprise of themselves a large number of distinguishable states. It is this indefiniteness, which is imposed by the non-selective character of the process of formation of the system that contributes towards a finite entropy at absolute zero. So it is suggested that a simple, comprehensive and sufficiently restrictive statement of the third law may be made in the form that "The entropy of any phase of sharply specifiable energy is zero at the absolute zero."

K. S. G. D.

Cataphoresis of Proteins.

WORKERS in the field of Colloid Chemistry and allied branches of Science will be deeply interested in the contribution by Kemp and Rideal (*Proc. Roy. Soc.*, 1934, **147A**, 1-21) on the Cataphoresis of Gliadin. They have by employing the microcataphoretic method, studied the mobility of Gliadin adsorbed on a fine suspension of Quartz. The Langmuir concept of adsorption of gases by surfaces has been applied to the solid-liquid interface. The cataphoretic mobility of quartz suspension is found to be a function of the concentration of the protein. The rate of adsorption of Gliadin by quartz is found to vary with the sign and magnitude of the charge on the protein, which in turn is governed by the pH. The charge on the quartz surface, however, is shown to depend upon the ion environment and not on pH. The effect of strong electrolytes on the mobility of Gliadin adsorbed on quartz has been studied from the theoretical and practical standpoint. It has been shown that the isoelectric point of proteins is profoundly influenced by the ionic strength of the medium. The acidic and basic dissociation constants have been determined by potentiometric titrations and the isoelectric point has been evaluated. The Debye-Huckel expression for cataphoretic migration has been found to hold good for not too high nor too low ionic strengths. The deviation from the formula, for the Cataphoretic velocity of Gliadin at higher ionic concentrations (using Acetate buffers) has been shown to be due to the adsorption of acetate ions. At low ionic concentrations, Donnan equilibrium between the protein particles and the intermicellary liquid results in an unequal hydrogen-ion activity between the two phases, which in turn brings about a change in the surface charge of the proteins. The importance of these considerations in the interpretation of Cataphoretic data can thus be easily seen.

M. P. V.

Investigations on the Nature of Hæmopoietin, the Antianæmic in Hog's Stomach.

L. KLEIN AND J. F. WILKINSON (*Biochem. J.*, **28**, 1684) in continuation of their work on the preparation of concentrates of hæmopoietin from the press juice of hog's stomach (*Biochem. J.*, **27**, 600), have come to several interesting conclusions with regard to the nature of the antianæmic factors present in stomach and liver. It is found that when concentrates of the hog's stomach extract which contain the antianæmic thermolabile hæmopoietin are incubated *in vitro* with beef muscle, a relatively thermostable hæmopoietically active substance is obtained. The product resembles very closely the active principle present in the liver and it can also be further concentrated into a form suitable for injections.

It is considered that the relationship between the antianæmic principles in stomach and liver is that of an enzyme to the end-product, the necessary substrate being provided by the constituents of beef. The action of this enzyme, hæmopoietin results in the production of an end-product which is also active in producing the red blood-cells. This latter principle is gradually stored up in the liver until it is required by the body. It is shown that this enzyme is different from pepsin because pepsin itself is not only clinically inactive but also cannot act similarly on beef muscle.

The results of Klein and Wilkinson are significant because they reveal that it is the stomach which is really the seat of the

production of the active hæmopoietic substances, the liver merely functioning as a storehouse. This observation is in conformity with the findings of Bence (*Wien Med. Woch.*, **2**, 1055) that if the stomachs of pigs were completely removed and the animals killed several months later, the antianæmic principle could not be found in the livers. In view of these findings the liver therapy in the remission of pernicious anæmia might be considerably altered.

H. B. S.

Supplemental Light and Blooming in Tropical Plants.

THE effect of additional day length produced by artificial illumination during the winter months upon 100 species of green-house grown (chiefly annual) plants is reported by Francis Ramaley (*The Botanical Gazette*, 1934, **96**, No. 1). Among the plants which were not affected in their blooming or which were actually retarded by increased day length there is a rather large proportion of tropical species; while very few, perhaps not any, tropical species are much hastened in blooming by increased length of light exposure. Of the plants hastened in blooming by supplemental light, most are natives of the temperate zone.

Standardization of Index Liquids.

THE identification of minerals under the microscope by making use of index liquids is becoming more and more common both among mineralogists and chemists. The liquids to be used should be colourless, chemically stable and should have as low a volatility as possible. Many mineralogists have been deterred from attempting to prepare their own set of liquids by the impression that it requires an elaborate technique to fulfil the above requirements. But J. J. Glass (*American Mineralogist*, **19**, No. 10, Oct. 1934) has shown that the United States Geological Survey prepare 50 sets of standard liquids every year. Since the determination of a large portion of minerals involves the use of liquids between 1·470 and 1·740, the three components which are made use of to prepare index liquids are Government oil (acid free, colourless, tasteless and odourless oil), monochlornaphthalene and methylene iodide. The properties of these liquids under varying conditions of temperature have been tested and it has been shown that they maintain a constant index. Since these liquids are miscible with one another, they can be conveniently used for determining the index range from 1·470 to 1·740. In further discussing the standardization of these liquids, he has shown that by using the prism designed by C. S. Ross, a chart can be prepared showing the relationship of angle of minimum deviation and the desired index of refraction. Since some of the liquids that are used at the present time are likely to change their properties including refractive index, when exposed to light and air, the suggestion of J. J. Glass might be usefully tried in geological laboratories.

Differentiation in Basalt Lava.

A DETAILED petrological study of plateau lavas of Antrim by S. I. Tomkeieff (*Geological Magazine*, No. 845, Nov. 1934) has revealed that the vast area of basalt covering nearly 1,550 square miles can be divided into two sets—the lower and the upper—separated by an inter-basaltic bauxito-lateritic zone. The lower layer is made up of olivine basalt (dolerite), a typical representative of hebridian plateau magma type. The upper layer is made up of two contrasted types, *viz.*, the Tholeiitic type (Non-porphyritic central magma type) and olivine basalt (dolerite) same as the lower lavas. These lavas are packed with zeolites and the most prominent of them are thomsonite, chabazite, levynite and gmelinite. The rocks have been analysed which show a gradual increase in the Niggli values of fm, mg, and k downwards and a decrease in al, c, alk. From this important observation Tomkeieff has been able to show that there was gravitational sinking of olivine without remelting. This is further supported by the occurrence of idiomorphic grains of olivine in the lower zone as contrasted with the allotriomorphic relationship of this mineral with the felspar in higher zones. He has further shown that this sinking of olivine was accompanied by rise of volatiles which is responsible for the formation of abundant zeolites. Since a great portion of the basalt is of the vesicular variety full of zeolites, he has suggested that the lava contained a considerable quantity of water.

Asphyxiation of Air-breathing Fishes of Bengal.

THE last number of the *Journal of the Asiatic Society of Bengal* (October 1934, **29**, No. 4, pp. 327-332) contains an account of "An Experimental Study of the Asphyxiation of some Air-breathing Fishes of Bengal" by the late Dr. Ekendranath Ghosh. The air-breathing fishes of India, such as *Amphipnous cuchia*, *Clarias batrachus*, *Heteropneustes fossilis*, *Ophicephalus* spp., *Anabas testudeneus*, *Fluta alba*, etc., etc., have, since a very early time, been the subject of considerable biological, experimental and morphological investigation. Usually a small vessel was used for experimental work, but Dr. Ghosh used a large tank for his experiments and thus reduced considerably the chances of the water becoming foul. He found that in his experiments most of the fishes (*Anguilla anguilla*, *Clarias batrachus*, *Ophicephalus striatus*, *O. punctatus*) survived under water for much longer periods than was hitherto possible, while *Heteropneustes* (=*Saccobranchus*) *fossilis*, *Mastacembelus pancalus*, *M. armatus* and *Rhynchobdella aculeata* could not be 'drowned'. In view of these results the author concludes that the "fish in the earlier experiments were asphyxiated as a result of insufficiency of normal water rather than for want of free air for aerial respiration". Dr. Ghosh has thus thrown considerable light on the bionomics of the air-breathing fishes of India and has shown that in experimental work on the air-breathing fishes all possible sources of errors should be eliminated to obtain satisfactory and reliable data.

S. L. H.

The Structure of the Corpus Luteum in Lower Vertebrates.

J. T. CUNNINGHAM AND W. A. M. SMART have examined the condition of the ovary in the Amphibia and the reptiles after ovulation induced by the injection of anterior extracts (*Proc. Roy. Soc. Lond.*, Nov. 1934, **116**, No. 798). It is seen that in *Xenopus*, where alone ovulation occurred after injection, the follicle cells were rapidly absorbed and no corpus luteum was formed. In *Lacerta*, chosen as a type of oviparous lizard, the same result is seen while in the viviparous lizards like *Anguis* and *Zootoca*, a distinct and well-developed corpus luteum is seen, comparable with that in mammals. The functions of the corpus luteum in various vertebrates are also discussed.

The Brain of *Echidna aculeata*.

A. A. ABBIE has made a signal contribution to our knowledge of the mammalian brain in his work on *Echidna* (*Phil. Trans. Roy. Soc. Lond.*, 1934, **224 B**, No. 509). Working under the direction of Prof. A. Kappers, the foremost authority on the structure of the mammalian brain, he has emphasised the primitive characters of the brain of *Echidna* and shown its similarities with its ally, *Ornithorhynchus*. The brain of *Echidna* is typically mammalian but the primitiveness of some of its traits is undoubted. The motor system, the dorsal situation of the nucleus ambiguus, the hypoglossal nucleus and the facial nucleus and the small pyramidal tracts are all primitive features. The hypertrophy of the trigeminal apparatus is a feature which *Echidna* shares with *Ornithorhynchus*. Indeed, in the latter there is a more pronounced development of this system. This has brought about a great expansion of the ventral nuclei of the thalamus. The cochlear connections are not well developed. The cerebellum is very greatly specialised; the cerebral peduncles are large but have no fronto-pontine tracts, a character with which *Echidna* agrees with *Ornithorhynchus* but differs from all other mammals. The presence of a temporo-trigeminal tract is peculiar to *Echidna*. Another primitive trait is the rudimentary fornix-mamillare-thalamic system. The epithalamus is well developed and is connected with the pars medius of the ventral nucleus of the thalamus.

Embryology of a Psocid.

W. FERNANDO in an interesting paper (*Quart. Journ. Micros. Soc.*, 1934, **77**, Pt. 1) described certain features in the development of the viviparous insect, *Archipsocus fernandi*, n. sp. The author points out that the yolk cells and the chorion are wanting. The ventral plate resolves itself into a median and two lateral plates. The former gives rise to mesoderm while from the latter the ectoderm is derived. The anterior and posterior rudiments give rise to endoderm. The usual insectan larval envelopes like the amnion and the serosa are formed.

The Chemical Nature of Enzymes.

By K. Venkata Giri, M.Sc., A.I.I.Sc.

Department of Biochemistry, Indian Institute of Science, Bangalore.

THE study of the chemical nature of an enzyme may be approached by both direct and indirect methods. The direct method of investigation consists firstly in obtaining an enzyme preparation freed as far as possible from associated impurities and subsequently in submitting the purified product to qualitative and quantitative chemical analysis. Among the indirect methods may be mentioned (1) observations on the inactivation of enzymes;[1,2] (2) attempts to alter the structure of the enzyme molecule by treatment of the enzyme preparation with reagents specific to certain chemical groups, and the examination of the influence of such treatments upon the activity;[3] (3) observations upon physico-chemical behaviour which, in some cases, have yielded very interesting confirmations of the findings of the more direct methods.[4,5,6]

In spite of the several efforts to purify enzymes by adsorption methods, first introduced by Willstätter, no success has so far been attained in identifying any of the known enzymes as a chemical individual. The view of Willstätter that an enzyme consists of a colloidal carrier and one or more chemically active groups, is supported by observations on the behaviour of enzymes and enzyme-like substances of known structure; the colloidal carrier determines the stability and the magnitude of the catalytic activity of the active groups, the latter being responsible for the specificity of the enzymes. Thus, the oxyhæmoglobin crystals isolated from the blood of different animals exhibit quantitative differences in their peroxidase activity, such differences being due to the association of the same active iron bearing dyestuff (hæmin group) with different globin complexes acting as carriers[7] and the water-soluble lyochromes the flavines, newly isolated by Kuhn, Warburg and their collaborators[8] which constitute vitamin B_2 and exhibit enzymic activity by their combination with a colloid carrier, afford typical examples of the composite nature of enzymes.

In recent years, the significance of the protein nature of enzymes has become the subject-matter of fruitful discussion between American workers on the one hand, and Willstätter and his colleagues in Germany, on the other. While Willstätter and his co-workers succeeded in obtaining protein-free preparations of saccharase,[9] amylase,[10] pepsin,[11] and urease,[12] the American workers have been equally successful in obtaining highly active preparations of a predominantly protein character. The isolation of urease by Sumner,[13] pepsin by Northrop,[14] trypsin by Northrop and Kunitz,[15] chymotrypsin by Kunitz and Northrop,[16] amylase by Caldwell, Booher and Sherman,[17] and lipase by Baman and Laeverenz[18] in the form of crystallised proteins may be mentioned among the important preparative successes. But the question whether the protein forms an indispensable constituent of the enzyme molecule still remains unsettled.

Several important papers on the chemical nature of amylase have recently been published. The protein nature of pancreatic amylase postulated by Sherman and his co-workers[19] has been questioned by Willstätter and his associates[10] who obtained highly active protein-free preparations through adsorption methods. In the case of vegetable amylases, the chemical nature of the enzyme is far less decisive and consistent.[20] The author[21] has recently reported the isolation from sweet potatoes by repeated adsorption on alumina gel, elution and dialysis, of a very active amylase preparation, free from proteins and has thus shown that the enzyme is neither a protein nor contains protein as an essential constituent.

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1932, **205**, 193. [13] Sumner, *J. Biol. Chem.*, 1926, **69**, 435; **70**, 96. [14] Northrop, *J. Gen. Physiol.*, 1931, **13**, 739. [15] Northrop and Kunitz, *J. Gen. Physiol.*, 1932, **16**, 295, 323, 339. [16] Kunitz and Northrop, *Science*, 1933, **78**, 558. [17] Caldwell, Booher and Sherman, *Science*, 1931, **74**, 37. [18] Bamann and Laeverenz, *Zeitschr. f. Physiol. Chem.*, 1934, **223**, 1. [19] Sherman and Schleisinger, *J. Amer. Chem. Soc.*, 1915, **37**, 1305; Sherman, Caldwell and Adams, *Ibid.*, 1926, **48**, 2947. [20] Sherman, Caldwell and Doebbeling, *J. Biol. Chem.*, 1934, **104**, 501; Fricke and Kaja, *Ber.*, 1924, **57**, 310. [21] Giri, K. V., *Biochem. Z.* (In press.)

Diffraction of Matter.*

By Dr. S. Ramaswamy, B.Sc., Ph.D.

MATTER is built up of two types of entities called "Electrons" and "Protons," the behaviour of which in large-scale electric or magnetic fields can be explained satisfactorily by assuming them to be particles with definite mass and electric charge subject to the ordinary laws of mechanics. But phenomena like spectral emission and the photoelectric effect cannot be explained on these lines. The new mechanics developed by De Broglie, Schrödinger, Heisenberg, Born and Dirac leads to the same result as classical mechanics in large-scale phenomena and, at the same time, solves the problems of atomic mechanics. In this new treatment called Wave Mechanics, a beam of electrons is represented by a wave train with a wave-length $\lambda = \frac{h}{mv}$ where h is Planck's constant, v is the velocity and m the mass of the individual electrons. The knowledge of the position of the electrons is represented by a "wave packet" or group of waves.

If electrons can be treated as waves, they ought to be diffracted by a lattice like the regularly arranged atoms in a crystal in very much the same way as X-rays and light. This was verified experimentally by G. P. Thomson, and Davisson and Germer almost simultaneously in 1928.

G. P. Thomson allowed a fine pencil of cathode rays from a discharge tube to pass through a very thin film of gold and then fall on a photographic plate. The apparatus was kept completely evacuated in order to prevent absorption of the electron beam. A ring pattern was produced on the photographic plate showing that the electron beam had been diffracted by the polycrystalline gold film. The wavelength calculated by assuming the lattice constant of gold agreed with that obtained from the relation $\lambda = \frac{h}{mv}$. This phenomenon of diffraction of electrons offers a method which has been successfully employed for the investigation of the structure of thin films, surface phenomena, the nature of polished surfaces and other allied problems.

Davisson and Germer used slow electrons from a hot filament, speeded up by applied potentials of between 60 and 600 volts, incident on one of the faces of a single crystal of nickel, the diffracted beam being detected by a moveable Faraday chamber. The position of the diffraction maxima was not quite what should be expected from theory. This discrepancy can be explained by assuming an "internal potential" for the crystal. This internal potential is found to be related to the electrical conductivity and is about 16 volts for nickel.

A fast electron beam falling on a small single crystal gives rise to an extended pattern of diffracted beams very much similar to those obtained with "crossed gratings" and monochromatic light. Using a thin sheet of mica, Kikuchi obtained a pattern similar to what would result from a two-dimensional grating of the type of a single sheet of atoms in the crystal. Condition for interference depends on two factors, the first of which is responsible for the cross grating effect and determines the position of the spots. The other factor depends on reinforcement of waves coming from points in a vertical row and the diffraction spots will be strong if this is strong and weak if this is weak. The second factor is obviously very small for extremely small crystals and comes into play for thicker crystals. The pattern obtained changes accordingly with the thickness of the crystal. Besides these factors the interaction of the incident and diffracted beams of electrons, which is absent in the case of X-rays, has also to be taken into account for a rigorous explanation of these facts.

Electron diffraction offers an excellent weapon for the study of the structure of free molecules, *i.e.*, molecules in the gaseous state. X-ray analysis of crystals sometimes leads to the determination of the structure of molecules forming the crystal. But the method is laborious and depends on tiresome elimination of all interference phenomena arising from crystal symmetry. The molecules in gases and vapours, however, are sufficiently independent of one another to ascribe the intensity distribution obtained definitely to "intramolecular" interference unadulterated by "intermolecular" effects. Using a fast electron beam and a jet of vapour Wierl has studied the structure of CCl_4 and other tetrachlorides. The distances between carbon atoms obtained agree with those calculated from X-ray data. Electron diffraction thus offers a powerful weapon for testing molecular models.

Electron diffraction is a new method of analysis and the exploration of its possibilities is still in its initial stages. This is merely an attempt to give typical illustrations of the interesting effects produced by the diffraction of material waves.

* Abstracted from a lecture delivered under the auspices of the South Indian Science Association, Bangalore, on 10th September 1934.

Science Notes.

A New Species of *Indobatrachus* from the Frog beds of Worli Hill, Bombay.—In a recent communication sent to us, Mr. G. W. Chiplonker (of the Geology Department, Benares Hindu University) records the occurrence of a new species of *Indobatrachus* from the Eocene fresh water beds of Bombay island. The author points out that this new species differs from *I. pusillus* (Owen) in several respects such as the ratio of the length of the vertebral column to that of the pelvis, the ratio of the femur to that of the tibia, the ratio of the length of the hind limbs to that of the body, etc. The new species is proposed to be called *Indobatrachus trivialis*.

* * *

A Portable Electroscope for ascertaining the Radioactivity of Spring Waters, natural gases and minerals.—An ordinary monthly meeting of the Asiatic Society of Bengal was held on Monday the 3rd December 1934, when several interesting papers were read and discussed. Mr. Cyril S. Fox described and exhibited a field Electroscope which he employed for the examination of several mineral and thermal springs in Abyssinia. "The normal procedure is to take a definite quantity of the spring water and after strong agitation in a special vessel the gas evolved is passed into a suitable chamber in the electroscope. The natural leakage of the apparatus having been previously determined the rate of fall of the leaf due to the introduction of the radon forced out of the water is next taken. The difference is due to the radon and this compared with a standard gives the radio-activity of the water in terms of radium.

"There are naturally a number of corrections and other calculations to be made before the final estimate is obtained, but for this field apparatus these are reduced to a minimum by the design of the vessels and electroscope employed. The investigation so far as the author knows is the first of its kind outside Europe and no instrument of this type is available in England or India at the present time.

"It may be mentioned in passing that very hot springs are not likely to contain radon as the gas is not retained by the water if the temperature exceeds 150° F. On the other hand, true radium carrying waters are very rare because radium salts are relatively insoluble and are precipitated as the water cools."

* * *

Textile Research at Calcutta.— Dr. S. G. Barker, who recently resigned his post as Director of Research to the British Wool Industries Research Association, has been invited to organise a branch of textile research at Calcutta. Dr. Barker is one of the best known amongst those who have harnessed scientific research for the improvement of industrial processes and his investigations at Torridon have proved to be of the greatest benefit to the British Wool Textile trade.

* * *

The British Industries Fair, 1935.—The next British Industries Fair will open in London at Olympia and the White City on Monday, the 18th February 1935, and will close on Friday, the 1st March 1935.

The Indian Trade Commissioner in London has decided to participate in this Fair and intends to display a representative collection of Indian produce and manufactures of commercial importance and possibilities.

Firms wishing to exhibit their products at this Fair should communicate with the Indian Trade Commissioner, "India House", Aldwych, London W.C.2, who will be pleased to make arrangements for their display on the Indian Stand.

As the Fair is attended in large numbers by buyers from most parts of the world, the exhibits are likely to receive wide-spread notice which may lead to satisfactory business connections. Booklets and show-cards relating to the Fair have been received from His Majesty's Trade Commissioner in India, Calcutta and may be seen in the Commercial Library and Reading Room at 1, Council House Street, Calcutta. (*The Indian Trade Journal*, 1934, **115**, 787.)

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Third International Congress of Soil Science, Oxford, England, July 30th—August 7th, 1935. The Congress will be held by the International Society of Soil Science, under the general patronage of the International Institute of Agriculture, Rome, and is open to all interested in Soil Science, Agriculture, Forestry and allied Sciences. It will be followed by an excursion through Great Britain, in which all who attend the Congress are invited to take part.

Meetings of the General Committee of International Society of Soil Science will be held on the afternoon of Monday, July 29th, 1935, and on the morning of Tuesday, July 30th. The Inaugural Session of the Congress will be held and the Presidential Address will be given on the afternoon of Tuesday, July 30th. The Closing Session will take place on the afternoon of Wednesday, August 7th.

The Congress will meet as a whole at plenary sessions, and in sections at separate or joint sessions of the different Commissions through which the work of the Society is conducted. The subjects which will be dealt with by the Commission are: (1) Soil Physics, (2) Soil Chemistry, (3) Soil Microbiology, (4) Soil Fertility, (5) Soil Genesis, Morphology and Cartography, (5*a*) Alkali soils, (5*b*) Forest soils, (6) Application of Soil Science to land amelioration, (6*a*) Peat soils.

Plenary Sessions will be held on the mornings of July 31st and August 1st, 2nd, 5th, 6th and 7th. One Plenary Session will be conducted by each of the six main Commissions of the Society; at each Plenary Session, recent advances in that branch of Soil Science covered by the work of the Commission concerned will be reviewed in relation to Soil Science as a whole. A number of excursions of both scientific and general interest will take place on Saturday, August 3rd, and Sunday, August 4th.

* * *

It is understood that the *Fourth British Empire Forestry Conference* which was to have been held in 1933 but which was not held owing to depressing economic conditions will be held next year in South Africa, provided there is a reasonable prospect of the various parts of the Empire being well represented. The previous three Conferences

were held in London in 1920, in Canada in 1923 and in New Zealand in 1928. The fifth Conference, which is held once in a quinquennium, is to come off in 1940 and will be presumably invited to India, announcement to which effect was made by the Indian Delegate Sir Peter Clutterbuck, at the last Conference in Australia.

* * *

Royal Institute of Science, Bombay.—A Scientific Exhibition in aid of the Special Appeal Fund for Bombay Hospitals was opened in this Institute on the 13th of December, under the patronage of His Excellency the Governor of Bombay and continued for 5 days.

* * *

We are in receipt of the third issue of the *Royal Institute of Science Magazine*, Bombay, and we welcome it. Started "to seek out the causes of things" the *Journal* abounds in interesting articles on subjects like Heavy Water, Heavy Hydrogen, Wireless, etc. The editorial chat begins with an account of the part that the staff members of the Institute played during the Science Congress held in Bombay in January 1934 and ends with a list of original publications from the Institute. Judging by the numbers of papers, the Chemistry Department is very active while its sister departments like Physics, Botany and Zoology are also active. We wish the *Journal* a life of active useful service for the cause with which it was started.

* * *

Meteors and Meteoric Iron in India.—Mr. Mohd. A. R. Khan, A.R.C.S., B.Sc., F.R.A.S., Principal, Osmania University College, Hyderabad, in the course of the Presidential Address delivered before the meeting of the Hyderabad Science Association, on 14th July, gave a brief account of the main facts concerning meteors and meteorites with special reference to meteoric iron in India. An abridged text of the address has recently been published in the form of a pamphlet, which makes a very interesting reading. As a member of the Society for research on meteorites and a modest collector of the interesting objects himself, his address bears a stamp of authority and we feel sure that the pamphlet would be widely read and appreciated.

The account of the iron meteorite that fell in the reign of Jehangir (described on pages 12-14) may perhaps induce some enthusiastic readers to inquire about the two swords that were made from it, in responsible quarters.

Needless to say that any authentic information bearing on the subject either of unrecorded meteorite falls, or of the two swords above referred to, or in fact, of any other article manufactured from an iron meteorite in India, will be most gratefully acknowledged by the author.

* * *

Lanolin Rust Preventers.—Engineering Research Special Report No. 12, (2nd Edition). His Majesty's Stationery Office. The original edition of this report being nearly exhausted a second edition has been prepared. A considerable amount of further information is now available. In particular, 'life' tests extending over a period of five years on articles coated with recommended lanolin mixtures have been completed, and have given full proof of the protective value of the material. The new edition gives a complete account of the investigations undertaken together with the confirmatory tests carried out and the opportunity has been taken to include certain further recommendations which are considered desirable.

* * *

We are happy to felicitate Dr. Bawa Kartar Singh, I.E.S., on his being appointed Principal, Ravenshaw College, Cuttack. Prof. Singh was born in 1886 at Vairoval, Amritsar. He graduated in 1906 and after four years of post-graduate research work at London and Cambridge, he returned to India and was appointed Professor of Chemistry at Dacca College where he served till 1918. Since then, he held the Professorships at Government College, Lahore and Patna College. He was appointed Senior Professor of Chemistry, Ravenshaw College, Cuttack, in 1921, which post he has been holding ever since. He was President of the Indian Chemical Society, 1931-33 and President of the Chemistry Section, Indian Science Congress, 1920. Dr. Singh has built a school of research in Chemistry at Cuttack and is well known for his keen interest in educational affairs.

* * *

J. N. Das Memorial Medal.—Applications are invited for the award of a Gold Medal of the value of Rs. 70 (Rs. 100 for 1934) in memory of late Mr. J. M. Das Gupta. The medal will be awarded every alternate year to the best candidate for investigation on a subject relating to any branch of chemistry on the following conditions:

(1) Only unpublished researches or those published in the *Journal of the Indian Chemical Society* during the period shall be taken into consideration.

(2) The Society shall have the right to publish in its *Journal*, the whole, a part, or a modified form of thesis for which the medal is awarded.

(3) The medal shall not be awarded more than once to the same candidate.

(4) No paper on the presentation of which any other prize or degree other than M.A. or M.Sc. has been obtained, will be accepted. Further information can be obtained from the Hony. Secretary, Indian Chemical Society, 92, Upper Circular Road, Calcutta.

* * *

We acknowledge with thanks the receipt of the following:—

"The Journal of Agricultural Research," Vol. 49, Nos. 4 and 5.

"Indian Journal of Agricultural Science," Vol. 4, Pts. 4 and 5.

"Contributions from Boyce Thomson Institute," Vol. 6, No. 3.

"The Journal of the Indian Botanical Society," Vol. 13, No. 3.

"The Journal of the Institute of Brewing," Vol. 40, Nos. 10 and 11.

"Canadian Journal of Research," Vol. 2, No. 4.

"The Chemical Age," Vol. 31, Nos. 799 to 803.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 67, No. 11.

"The Cambridge Bulletin," No. 75, Nov. 1934.

"The Experimental Station Record," Vol. 71, Nos. 3 and 4.

"Educational India," Vol. 1, No. 5.

"Indian Forester," Vol. 60, No. 12.

"Forschungen und Fortschritte," Jahrgang 10, Nos. 30 and 32.

"The Journal of the Geological, Mining and Metallurgical Society of India," Vol. 6, No. 3.

"The Indian Trade Review," Vol. 12, No. 70.

"Research Publications of the Punjab Irrigation Research Institute".—

Vol. 1, No. 4. April 1933. An Investigation of the rise of water table in the Chenab Canal area, Punjab.

Vol. 2, No. 6, February 1934. An Investigation of the flow of water in Khanki Weir and the pressures on the floor.

Vol. 3. No. 1. An Analysis of the Utilization of Irrigation Water in Typical Punjab Canals.

Vol. 4, No. 1, February 1934. A gravimetrical survey of the Sub-Alluvium of the Jhelum-Chenab-Ravi-Doabs and its application to problems of waterlogging.

Vol. 4, No. 6, A simple method for determining the reaction and titration curves of soils.

Vol. 5. No. 2, January 1934. The Transmission coefficients of water in natural silts.

"Monthly Statistics of the Production of certain selected Industries of India," August 1934 (Government of India Publication).

"Communications from the Kamerlingh Onnes Laboratory of the University of Leiden," 224-228; Vol. 20, Supplements Nos. 70-75. November 1931 to September 1933, Nos. 217-228.

"The Association of Special Libraries and Information Bureaux; Report of the Proceedings of the 11th Conference."

"Advance Proceedings of the Asiatic Society of Bengal," Vol. 1, No. 2, November 1934.

"Report of the Forest Research Board for the year ending 31st March 1934 with Report of the Director of Forest Research," published by His Majesty's Stationery Office, 1934.

"Mathematics Student," Vol. 1, 1933.

"Memoirs of the Indian Meteorological Department," Vol. 26, Pt. 4, Discussion of Results of Sounding Balloon Ascents at Poona and Hyderabad during the period October 1928 to December 1931.

"Scripta Mathematica," No. 4, August 1934.

"Nature," Vol. 134, Nos 3390—3394.

"Natural History," November 1934.

"The Journal of Nutrition," Vol. 8, No. 4.

"The Journal of Chemical Physics," Vol. 2, No. 11.

"Journal de Chimie Physique," Tome 31, No. 8.

"Indian Journal of Physics," Vol. 9, Pt. 1, Proceedings of the Indian Association for the Cultivation of Science," Vol. 18, Pt. I.

"The R.I.S. Magazine," Vol. 1, No. 3, September 1934.

"Records of the Indian Museum," Vol. 36, Pt. 3.

"The Review of Scientific Instruments," Vol. 5, No. 10.

"The Indian Trade Journal," Vol. 115, Nos. 1481-1485.

Reviews.

ACTUALITIÉS SCIENTIFIQUES ET INDUSTRIELLES. No. 123. Les Surfaces Algebriques non Rationelles de Genres Arithmetique et Geometrique Nuls. By Lucien Godeaux. Pp 33. Price 10 Frs.

The conditions given by Enriques and Castelnuovo for a given algebraic surface of order n to be rational are (1) The surfaces of order $(n-3)$ passing $(i-1)$ times through every multiple curve of order i on the surface and $(j-2)$ times through every multiple point of order j should pass through all the adjoint curves of the sections of the surface on every plane of space; and (2) Surfaces of order $(2n-8)$ passing $(2i-2)$ times through every multiple curve of order i, and $(2j-4)$ times through every multiple point of order i do not exist. Now the condition (2) obviously includes the following condition, *viz.*, (3) The surfaces of order $(n-4)$ passing $(i-1)$ times through every multiple curve of order i and $(j-2)$ times through every multiple point of order j do not exist.

This monograph deals with the general construction and properties of surfaces for which the conditions (1) and (3) are satisfied and (2) is not satisfied; or in other words surfaces whose arithmetical and geometrical deficiencies are zero. The first example of such a surface given by the authors mentioned earlier is the quartic surface having the sides of a tetrahedron as double lines. The first few pages of the book are devoted to a sketch of the elementary theory of algebraic surfaces and the reader is referred to the standard works of Severi and Picard-Simart for details and further development. Next the determination of the deficiencies of higher orders of the various special surfaces in view is treated. It is shewn that the bigenre or the deficiency of the second order of the previously-mentioned surfaces is one. It is interesting to note that Enriques has proved that all surfaces whose arithmetical and geometrical deficiencies are zero and whose bigenre is unity is birationally equivalent to this surface. Next we find the proofs of the existence and some properties of Castelnuovo's surface, *viz.*, a seventh degree surface having a triple line R and a double conic r which does not intersect R and which has three tacnodes A, B, C, whose tacnodal planes pass through R. This surface also belongs to the species of surfaces in view. The monograph ends with

the general method of constructing such surfaces. One interesting example of such a surface given by the author is a seventh degree surface circumscribed to a tetrahedron having as tacnodal curves any four sides of the tetrahedron forming a skew quadrilateral. The book presupposes on the part of the reader a good knowledge of the theory of algebraic surfaces.

K. V. I.

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ELEMENTARY QUANTUM MECHANICS. By R. W. Gurny. (Cambridge University Press, 1934; pp. 160). Price 8*s*. 6*d*. net.

Books on Quantum Mechanics can well be divided into three classes. Books like those of Dirac, Weyl and Neumann appeal to the mathematician and mathematical physicist, while those of Darwin and Lindemann serve the layman. A third class typified by Frenkel's first volume and Mott's outlines is intended for the consumption of the experimentalist. The book before us definitely belongs to the last category and among books of this nature, it breaks new ground in its method of presentation. It is best described by altering its title to "Anschaulich Quantum Mechanics" if such a medley of words were permissible. The author very ingeniously carried out the programme of "fitting" ψ-patterns into potential boxes by means of a large number of carefully thought out diagrams. The advantages of this graphical method have really been two-fold. It has not only been possible to explain the fundamental principles clearly, but space has been found to deal with a large number of important applications in a semi-quantitative manner. As examples might be cited the sections on diatomic molecules, valence bonds, electrons in crystals, insulators and conductors, excitation and dissociation. More than to the experimentalist, this book will be found to be of value to the mathematician and will prove to him a sort of an oasis in the middle of the arid desert of quantum symbolism.

There is a short mathematical appendix at the end, but it is doubtful if it will serve any useful purpose; for no physicist, even an experimentalist, who does not know the mathematics contained in the appendix, is likely to be benefited by the book. The author has, in our opinion, very wisely refrained from giving an account of the Dirac theory of the electron.

Nothing need be said as regards the printing since it has been done at the Cambridge University Press. The price too is very reasonable.

B. S. M.

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THE DIFFRACTION OF X-RAYS AND ELECTRONS BY AMORPHOUS SOLIDS, LIQUIDS AND GASES. By J. J. Randall. (Chapman and Hall, xii + 290, 1934.) Price 21*s*.

The book under review is a welcome addition to the literature on the subject and a mere perusal of it will show that it will be one of the best works on that subject.

Beginning with a brief survey and touching on the essential elementary principles of X-Ray crystallography, the author proceeds to deal with the Diffraction of X-Rays and Electrons by Gases and Vapours. Appropriately enough Chapter V has been dealt with in detail. Starting with the historical aspect of the problem of Diffraction of X-Rays (and Electrons) by Liquids he gives the different theories advanced by workers like Raman, Stewart, Prins and Debye. Next he discusses the experimental results obtained with both organic and inorganic liquids in the light of the above theories. The remaining chapters of the book are devoted to subjects like:— Some Important Examples of Amorphous and Microcrystalline Solids; The Structure of Organic Fibres; X-Rays, Electrons and Surface Structure; The Transition from Solid to Liquid; Isotropic Melts. Finally at the end, the author has given tables of Atomic Scattering Factors for X-Rays, Tables of Atomic and Ionic Radii and Tables of $\frac{\text{Sin } x}{x}$ the value of which is evident to those working on this and allied subjects.

Speaking about the development of the subjects dealt with by the author one is struck by the clear and logical treatment aided by the accompanying set of beautiful photographs which is a characteristic feature of this book. The book supplies a long-felt need by workers on X-rays and electron diffraction since other treatises on X-rays and crystal structure make but a passing reference to such problems as the examination of amorphous solids, liquids, gases and surfaces by X-rays and electron diffraction methods. A comprehensive bibliography is given at the end of each chapter which will be found of great use. We have no hesitation whatever in

recommending the book to advanced students of Physics and workers on X-Rays and Electron Diffraction.

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BIOCHEMICAL AND ALLIED RESEARCH IN INDIA IN 1933. Society of Biological Chemists (India), Indian Institute of Science, Bangalore.

The volume under reference is the fourth annual publication issued by the Society and covers most of the work published during 1933. The present one differs from its predecessor in that a chapter on Agricultural Industries is included, while General Microbiology is omitted. The total number of 238 references which are abstracted in this pamphlet is sufficient testimony to the volume of work conducted in the different scientific departments and in the various research institutions and colleges. Problems relating to agriculture and animal nutrition have naturally engaged the attention of investigators and many of them still await solution.

It will be quite useful if the Committee of Publication preface the publication with a short critical review of the most outstanding contributions that have been made during the year. There is no doubt that the value of the booklet will be greatly enhanced.

The get-up of the book is neat and the Society has to be congratulated on its efforts. It is probably an omission that the price of the pamphlet is not stated.

V. I.

Forthcoming Events.

Indian Science Congress, 1935.

The Twenty-Second Annual Meeting will be held in Calcutta from January 2nd to 8th, 1935. Dr. J. H. Hutton, M.A., D.Sc., C.I.E., I.C.S., F.A.S.B., Deputy Commissioner, Naga Hills, Kohima, Assam, will preside.

Society of Biological Chemists, India.

January 5th, 1935, 3 p.m. Annual General Body Meeting at Calcutta.

Lucknow University, Faculty of Science.

Special Lectures, Session 1934-35.

The following short courses of Special Lectures have been organised at the invitation of the Inter-University Board and in pursuance of recent resolutions passed by the Faculty of Science and the Academic Council of Lucknow University. While the main object is to promote advanced study and research, it has been arranged that at least in some cases the introductory lecture in each course should present the more general and popular aspects of the subject, as far as possible in a non-technical manner. It is thus hoped to stimulate the interest of the educated public and of scientists working in related fields.

Jan. 12, 13, 14, at 6-30 p.m. Biology Theatre.

"Respiration in Plants." By Mr. H. P. Chowdhury, Lecturer in Botany.

Jan. 19, 20, 21, at 6-30 p.m. Chemistry Theatre.

"Liesegang Rings and the Influence of Media on their Formation." By Dr. A. C. Chatterji, Lecturer in Chemistry.

Jan. 26, 27, 28, at 6-30 p.m. Physics Theatre.

"Magnetism in relation to Chemical Problems." By Dr. K. N. Mathur, Lecturer in Physics.

Jan. 29, 30, 31, at 6-30 p.m. Chemistry Theatre.

"Photochemical Processes." By Mr. P. S. Mac Mahon, Professor of Chemistry.

Feb. 2, 3, 4, at 6-30 p.m. Biology Theatre.

"Saltation and Related Phenomena in Fungi." By Dr. S. N. Das Gupta, Reader in Botany.

Errata.

Vol. II, No. 12, pp. 464-66, "Studies on the Pollen Tubes."

In Table 3, *read* 4·7, 5·2, 5·7, 6·2, 6·7, 7·2, 7·7, 8·2, 8·7, 9·2, 9·7

for 47, 52, 57, 62, 67, 72, 77, 82, 87, 92, 97.

Vol. III, No. 5, page 201, column 2, line 5 from top, *read* 0·02 mg. *for* 0·2 mg.

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